THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

ART. I.—*On some phenomena of Binocular Vision*;* by JOSEPH LECONTE, Prof. of Geol. and Nat. Hist., Univ. of California.

V. *Stereoscopic phenomena.*

IT is a familiar fact that in stereoscopic pictures, properly mounted, identical points in the foregrounds of the two pictures are always a little nearer together than identical points in the backgrounds. With a pair of compasses we can, by this means, easily test whether or not pictures are properly mounted. It is evident therefore that it requires greater optic convergence to unite the foregrounds than the backgrounds of the two pictures. It is also evident that we cannot at the same time and with the same convergence unite all parts of the pictures. When objects in the foreground are united, objects in the background are seen double, the images being *homonymous;* when objects in the background are united, then objects in the foreground are seen double, the images being *heteronymous*; when objects in the middle ground are united, then both fore and background are doubled but in different directions. In looking at pictures in a stereoscope, therefore, the eyes range rapidly from fore to background and *vice versa*, uniting the objects successively, and finding the visual phenomena precisely similar in all respects to natural vision of near and distant objects, instinctively introduces the idea of depth of space. Or even looking *steadily* at any point, say in the middle ground, the depth of space is still perceived, as in nature under similar circumstances, and for the same reason, viz: that the *eye or the mind, instinc-*

* For the preceding articles on this subject, see II, xlvii, 68, 153, and III, 1, 33.

tively distinguishes between homonymous and heteronymous images, referring the one to a position *beyond*, and the other to a position *on this side* the point of sight.

This last point is so important in the theory of binocular perspective, and so at variance with the accepted view on this subject that I must dwell upon it a moment. It is now generally admitted that Wheatstone's idea of *a complete mental combination of dissimilar pictures or images is not true*, either in stereoscopic experiments or in natural vision;* but the theory which has displaced Wheatstone's, and which is now generally held, though certainly true, is, I believe, still *imperfect*. According to Brücke, Brewster, Prevost and others, the highest authorities on this subject, binocular perspective is *wholly* the result of rapid changes of convergence, or what I have called ranging of the eyes back and forth from foreground to background and *vice versa*.† I think, however, close attention to our visual perceptions will confirm the popular notion that *we distinctly perceive depth of space or the relative distance of objects while gazing steadily at one point*, even in those cases in which we are unassisted in our judgment by any other form of perspective. This is accounted for on the principle just announced, viz: that the eye instinctively distinguishes between homonymous and heteronymous images, referring the former to objects *beyond* and the latter to objects *on this side* the point of sight, or in other words, each eye knows its own images. It is true we are not usually *conscious* of making this distinction, but the same is true of the rapid changes of convergence and many other visual phenomena upon which judgments are based. The observation of Dove mentioned by Claparède‡ that stereoscopic relief is distinctly perceived by *the light of an electric spark*, and the undeniable fact that such relief is distinctly perceived by *the light of a flash of lightning*, cannot be explained by the usual theory. According to Wheatstone's well-known experiments in 1835, the duration of an electric spark from a Leyden jar is $\frac{1}{24000}$ (·000042) of a second.§ The later experi-

* Mr. Townes in the elaborate paper "on the physiology of vision" already alluded to in my last paper, (III, 1, 33,) devotes much time and many experiments to the subversion of this view, under the impression that it is still the universally accepted view.

† See an admirable review of the whole subject by Claparède, Bib. Univ. Archives des Sci. Nouv. Per., vol. iii, p. 138 and seq.

‡ Ibid. p. 155.

§ I give Wheatstone's result on the authority of De la Rive, (vol. ii, p. 184, trans.) and of Daguin (vol. iii, p. 518, trans.). It is somewhat remarkable that nearly all writers on physics give Wheatstone's result as a little less than $\frac{1}{100000}$ instead of $\frac{1}{24000}$ of a second. Prof. Rood in his recent admirable researches on this subject has unfortunately fallen into the same mistake. The $\frac{1}{100000}$ of a second does indeed occur in Wheatstone's paper, but it is the time occupied by the electric current in passing from one interruption of the wire to

ments of Fedderson in 1858, and of Prof. O. N. Rood in 1869, give nearly the same results; the former ·00004 of a second, and the latter from ·000022 to ·000050* depending upon the degree of the charge and the length of the spark. The duration of a flash of lightning, according to Rood,† is about $\frac{1}{5\,0\,0}$ of a second. Now it is obviously impossible that in $\frac{1}{2\,5\,0\,0}$ or even in $\frac{1}{5\,0\,0}$ of a second the eye can change its convergence so as to adapt it consecutively to single visions of different objects at different distances. The perception of stereoscopic relief under these circumstances is therefore inexplicable on any other theory than that which I propose. The *true theory* of binocular perspective seems, therefore, to be this: *the eye, even when fixed steadily on one point, perceives the relative distance of objects by means of double images, as already explained; but this perception is made much clearer by the ranging of the eyes back and forth, uniting successively the images of near and distant objects.*

If the pictures on a stereoscopic card be *reversed*, i. e. the right picture placed on the left side and the left picture on the right side, *the binocular perspective is also reversed*, the objects in the foregrounds being seen at a distance, and objects in the backgrounds near at hand; in other words, the foregrounds of the pictures become the background of the scene, and the backgrounds of the pictures the foreground of the scene. The reason is obvious. By changing the pictures, identical points in the backgrounds become nearer together than those of the foregrounds. Thus greater optic convergence is necessary now to combine objects in the backgrounds of the pictures than in the foregrounds, and therefore by the principles of binocular perspective the former will appear nearer than the latter. These facts are illustrated in figs. 1 and 2, in which *S S* is the septum of the stereoscope, *r S* the right and *l S* the left picture, R and L the right and left eye, N the nose, *a a* identical points in the foregrounds, *b b*‡ identical points in the backgrounds of the right and left pictures respectively, and A and B the places behind, where *a a* and *b b* are seen. Fig. 1 represents the result where the pictures are properly mounted, and fig. 2 when reversed. By comparing the two figures the reverse perspective and its cause becomes evident.

This inverse perspective was long ago pointed out and explained by Wheatstone, and stereoscopic pictures are often made expressly to exhibit it. I am not aware, however, that any one has drawn attention to the beautiful, and in some respects

another—*the time between the occurrence of the sparks and not the duration* of the sparks; it is measured by the *arc of displacement* of the image of middle spark, not by the *arc of elongation* of the images of the sparks. I am indebted to my brother Prof. John Le Conte for having directed my attention to this mistake.

* This Jour., II, vol. xlviii, p. 153. † This Jour., III, vol. i, p. 15.

‡ The italic *a* and *b* are *underlined* in the figures.

peculiar, results both of natural and inverse perspective, produced by the combination of stereoscopic pictures with *the naked eye* by *squinting*. I find that I am able to combine stereoscopic pictures in this way, quite as easily or even more easily than with the stereoscope. The results by this mode of combination differ from ordinary stereoscopic results in several respects. 1st. In combining on *this side* the plane of the pictures by squinting the *right-eye* image of the *left* picture, combines with the *left-eye* image of the *right* picture; while in combining *beyond* the plane of the pictures as in ordinary stereoscopic experiments, it is the right-eye image of the *right* picture, and the left-eye image of the *left* picture which combine to form the binocular result. This is evident on comparing fig. 1 with fig. 3. 2d. Besides the binocular result there are of course homonymous monocular pictures on the right and left; while in the stereoscope these monocular pictures (which, however, in this case would be heteronymous) are cut off by the septum. 3d. The binocular result, instead of being magnified as in the stereoscope, is seen in exquisite miniature and has all the charm of miniature pictures. 4th. The depth of perspective is proportionally less than in combination beyond the card. 5th. The perspective is always the *reverse* of that given by the stereoscope, and therefore, in order to produce the same perspective the *mounting* must be reversed.

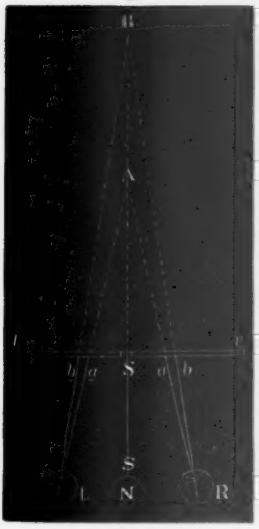
If ordinary stereoscopic photographs be reversed and the pictures be then combined *with the naked eye* by squinting, the stereoscopic effect is as perfect as can be imagined. Miniature houses, gardens, lawns, statuettes, fountains, &c., such as Gulliver might have seen in the land of Lilliput, are presented *in perfect perspective*. I have often amused myself by changing the mounting of stereoscopic pictures in order to enjoy the exquisite effect. Of course in order that there should be perfect definition of the objects, there must be complete dissociation of the focal and axial adjustments, as already explained in my first paper.* If stereoscopic pictures are combined by squinting *without reversing the mounting*, then of course the *perspective is reversed*. These facts are represented by figs. 3 and 4. Fig. 3 represents the combination of fore and background when the mounting is suitable for the stereoscope. By comparing this with fig. 1, the reversal of the perspective is obvious. Fig. 4, represents the combination of fore and background when the mounting is changed. It will be observed that the perspective is true.

In combining with the naked eye stereoscopic pictures mounted in the usual way, it is not always easy, sometimes it

* This Jour., II, vol. xlvii, p. 68.

is not possible, to bring out the inverse perspective distinctly. The reason is that it violates other kinds of perspective, and sometimes sets at defiance the known properties of bodies. It is most distinct when other kinds of perspective are least distinct. In natural vision there are many kinds of perspective, or many modes of judging of the relative distance of objects; viz. *aerial* perspective or increasing dimness with increasing distance; *mathematical* perspective or decreasing size with increasing distance; change of focal adjustment necessary for *distinct* vision of near and distant objects; change of axial adjustment necessary for *single vision* of near and distant objects. The first three of these are *monocular*, the last is *binocular*. The painter can give only the first two. The stereoscope gives also the last, and its surprising effects are due to this cause. In natural vision alone all kinds concur. Now in reversing the binocular perspective we do not affect the other kinds. There is therefore, a discordance between this and the other kinds, and when they exist it must overpower them. This it cannot do when the mathematical perspective is strongly marked. Thus the curious effects of inverse perspective is best seen when the other forms of perspective, particularly the mathematical, are least marked. It is impossible to see it in cases of long buildings or long rows of buildings taken in perspective. In such cases the mathematical overpowers the binocular perspective. But in buildings and grounds seen directly in front it is very evident. I now combine with the naked eye stereoscopic photographs, taken directly in front, of a building, the profile outline of which is given in fig. 5; as soon as by rectification of the focal adjustment the image becomes clear, the inverse perspective comes out distinctly as represented in fig. 6. The roofs *a a* and the lawn *b* slope away downward as if we were looking at them from beneath. They are transparent, however, for the grass on the lawn stands upright. The column *c* is seen beyond the house as if through a transparency or as if the wall of the building was wanting in that part. I now try a scene in Lombardy taken on glass. Viewed in the stereoscope a village is seen in the distance and a row of poplars far in front with their straight trunks projected against the houses of the village; combined by squinting the *village* is seen *in front* and the *trees* through the houses far *in the distance*. Next I try stereoscopic pictures of the full moon. In the stereoscope it is egg-shaped with the end of the egg toward the observer; combined with the naked eye, it is a *shallow concave* very perfect and beautiful. In a picture of Paris viewed in the same way, the mathematical perspective is entirely overpowered by the binocular perspective, and the city is seen sloping away downwards as if seen from beneath through a transparent ground, but with the smaller

1.



2.

3.

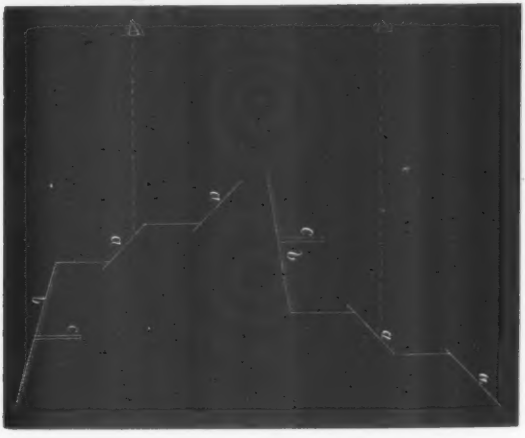
3.

4.

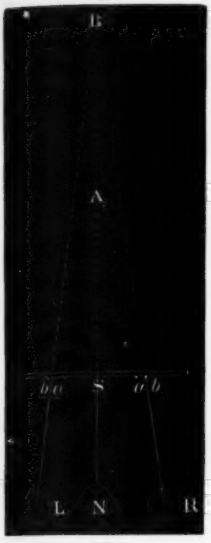
8.

6.

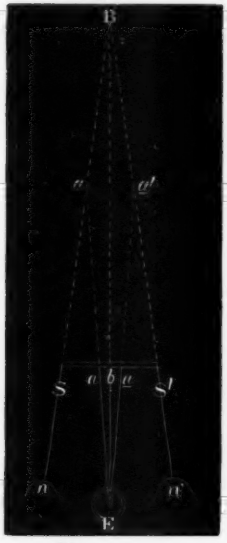
5.



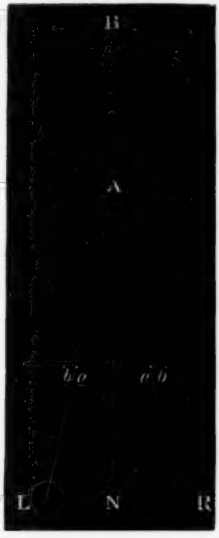
9.



10.

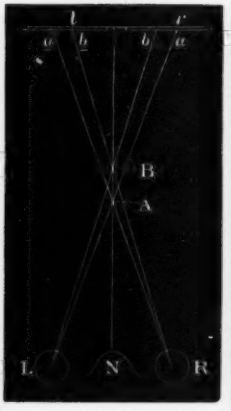


11.

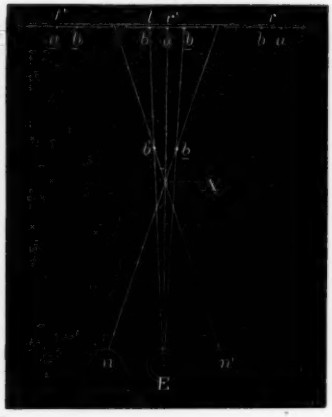


12.

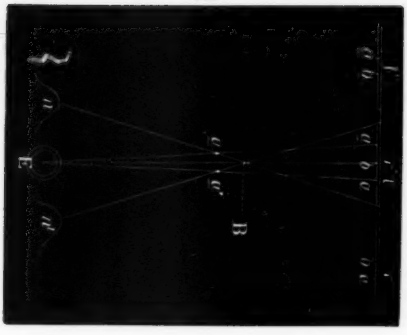
13.



14.



15.



houses above and nearer, and the larger farther away in the distance.

On combining in a similar manner one of those skeleton polyhedra so frequently used to illustrate stereoscopic principles, I find the stereoscopic effect equally perfect as with the stereoscope except that the nearer triangular face is *smaller* than the farther one instead of the contrary. Nothing can exhibit more clearly than these experiments, the entire distinctness of the binocular from every other kind of perspective.

Stereoscopic pictures may be combined with the naked eye, *also beyond* the plane of the card in the manner of a stereoscope; but there are two difficulties in the way of success in this kind of combination. In the first place in most stereoscopic pictures, identical points are farther apart than the eyes, and therefore, cannot be combined beyond the pictures without the aid of lenses or prisms. In the second place, even if the pictures are not farther apart than the eyes, and may therefore be thus combined, the dissociation of the focal from the axial adjustment, as already explained in my first paper* is difficult and imperfect, and the combined picture therefore is not clear.

I wish now to apply the method proposed in my last article, in the representation of stereoscopic phenomena. The usual method, which I have used in figs. 1, 2, 3, and 4, because it is familiar, represents perfectly the position of objects seen *single* and therefore their relative distance or the depth of space, when the eyes are directed upon them consecutively; but cannot represent the position of *double images* in the stereoscope any more than it can in natural vision. Fig. 7, gives the mode of representing by the usual method. A R, A L is the position of the optic axes when objects a a in the foregrounds are combined at A and bb'† the position of the double images of bb, seen at the same distance as A; B R, B L the direction of the optic axes when objects bb in the backgrounds are combined and seen at B and aa', the apparent position of aa at the same distance as B. Fig. 8 gives the same when pictures are combined by squinting.

Now it is evident that this mode of representation is not true, for we *do not* refer bb' to the same distance as A, when we look at A, nor aa' to the same distance as B when we look at B. The whole stereoscopic effect would be lost if we did. On the other hand my method of representation gives the true apparent positions of the double images as we now proceed to show.

When we gaze through a stereoscope the two pictures seem to slide inward over each other until they unite to form a single

* This Jour., II, xlvii, pp. 73 and 76.

† As in my previous article dashed letters mean *left-eye* images.

picture in the middle. The septum of the stereoscope is therefore doubled heteronymously, and forms two parallel planes or walls bounding the field of view on either side. Between these two bounding planes, the eye (combined eyes) from its apparent central position seems to look straight forward upon the scene. As soon as we converge the eyes upon any object in the scene, the two septa or bounding planes seem to converge to the same degree, and if produced would meet at the point of sight, if this be in the median line, or in any case at the *distance* of the point of sight. As the point of sight however, is always far beyond the septa, practically the septa will seem nearly or quite parallel. Fig. 9 gives the actual relation of parts and the position of the visual lines when b*b* objects in the backgrounds of the pictures are united and seen at B; fig. 10 gives the visual result. The two pictures are slid over each other each a half interocular space until b*b* fig. 9, unites in the middle *b* fig. 10, and a*a* slide by each other and become heteronymous. The combined picture *b* is seen at B (fig. 10), because we are conscious of an optic convergence suitable for that distance, or in other words we are conscious of *looking* at that distance. In this mode of representation the position of B, when it is on the median line, is determined by the intersection of the double septa or median lines $n\,S$, $n'\,S'$ produced; and the position of a*a'* of the scene is determined by the intersection of the lines from the eye through *aa* of the card (ray lines), with the median lines $n\,S$, $n'\,S'$. It will be observed that these double images occupy precisely the position of those of an object at A fig. 9. Fig. 11, gives the relation of parts and the direction of the optic axes, when objects a*a* in the foregrounds of the pictures are combined and seen at A, and fig. 12, the visual result. To combine a*a* (fig. 11), b*b* do not slide by each other, and are therefore homonymous, and are therefore referred beyond A and seen at b*b'* (fig. 12) precisely as if they were the double images of an object situated at B (fig. 11). In the representation (fig. 12) the exact position of b*b'* of the scene, is determined as before by the intersection of median lines with the *ray lines.*

The phenomena of combination by squinting is represented in figs. 13, 14, 15, of which fig. 13 represents the actual relation of parts, and the direction of the optic axes when foregrounds and backgrounds of the pictures *r* and *l* are consecutively combined. In this case the mounting is supposed to be changed so as to make the perspective natural. Fig. 14 represents the visual result when the foregrounds are united, and fig. 15, when the backgrounds are united. The positions of the double images in the scene are determined as before. In the case of combination by *squinting*, the two images of the card do not slide over each other *inward*, as in the stereoscope, but

outward; so that, as already stated, the *right-eye* image of the *left* picture covers the left-eye image of the *right* picture, to form the binocular picture or scene; while homonymous images of the right and left pictures are seen to the right and left. I have represented this in figs. 14 and 15, where r and l are right and left pictures as seen by the right eye, and r' l' the same as seen by the left eye. By careful inspection, after what I have already said, the figures will explain themselves. It is true, this mode of representation is complex, and, for those unaccustomed to binocular experiments, perhaps difficult to understand; but it has the advantage of truly representing the somewhat complex visual phenomena.

Oakland, Cal., March 20, 1871.

ART. II.—*On three Masses of Meteoric Iron, from Augusta Co., Virginia;* by J. W. MALLET, Professor of Anal. and Applied Chemistry, University of Virginia.

NEARLY two years ago I learned that a lump of iron, which from the description given of it I supposed to be meteoric, had been turned up by the plough in Augusta Co. in this State, and soon afterwards I obtained possession of this specimen by the kind assistance of Hon. J. B. Baldwin of Staunton. It proved to be beyond question a meteorite, weighing about 56 lbs.

A few months later, I saw at the Annual Fair of the State Agricultural Society in Richmond, a second mass, of smaller size, weighing about 36 lbs., which had come from the same county, and was exhibited along with some iron ores by Maj. Jed. Hotchkiss of Staunton. Learning from me that I was about to examine and analyze my own specimen, and was anxious to compare it with the other found in the same part of the country, Maj. Hotchkiss was obliging enough to lend me the latter, and to permit me to cut off enough for analysis.

Quite recently he has placed in my hands a third specimen—also from Augusta Co.—weighing but about 3½ lbs.

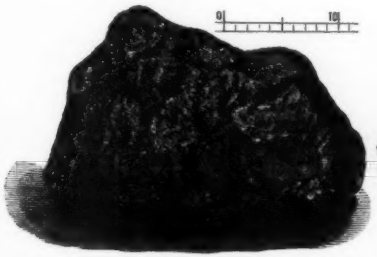
I shall speak of these three masses as No. 1, No. 2, and No. 3, in the order in which they are mentioned above; No. 1 being my own specimen, and Nos. 2 and 3 those of Maj. Hotchkiss.

All three present quite the same general appearance. They are of a very irregular pear shape, one end of each mass being larger and more rounded than the other—the smaller end of each is somewhat flattened, but by concave surfaces, in one direction. No. 1 was more massive and rounded than the

others—No. 2 most flattened—the latter had some rude resemblance in shape to a shoulder of mutton. The dimensions of the masses before cutting were as follows:

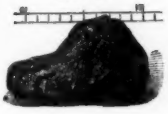
	No. 1.		No. 2.		No. 3.	
Maximum length,	28	centimeters	27	c. m.	11	c. m.
" width, at large end,	21	"	10	"	9	"
" " at small end,	17	"	19	"	5	"
" thickness, at large end,	13	"	13	"	8	"
" " at small end,	11	"	5	"	3	"

No. 1.



No. 2.

No. 3.



A pretty good idea of the shape and size may be obtained from the accompanying figures, from photographs of the original specimens with attached scale. The exact weights before cutting were,

No. 1.	No. 2.	No. 3.
25,429 grams.	16,441 grams.	1,644 grams.

the masses being entire, nothing having been previously detached from any one of them.

The surface of each of the masses is rough and irregular. At some points, which have been rubbed, the iron exhibits its metallic luster, and traces of its crystalline character may be observed, but nearly the whole surface is covered with a dark brown crust, consisting essentially of hydrated ferric oxide, which varies from about an eighth to a third of an inch in thickness. This crust is hard, and pretty firmly adherent. On exposure to moist air a rusty liquid exudes in drops from numerous points upon the surface, and in this watery liquid chlorine, iron (chiefly as ferrous chloride), and nickel were detected. The masses are of course magnetic, and on examination give evidence of feeble magnetic polarity, with multiple poles.

The union of hardness and toughness in the iron makes it quite difficult to cut, and in attempting to obtain with the planing machine a slice of considerable size the ordinary cutting tools were blunted and broken; it was found necessary to drill a row of holes and connect these by a cut made with the planer.

The specific gravity was taken for Nos. 1 and 2 with solid pieces of about 140 grams and 95 grams, respectively, cut from the interior of the masses, and for No. 3 with about 10 grams of clean shavings (from the planer) in a specific gravity bottle. The results were,

	No. 1.	No. 2.	No. 3.
Specific gravity, at 15° C.	7·853	7·855	7·839

The interior structure of the iron is compact and highly crystalline, of much the same general character throughout, but a few small grains and streaks of a brownish yellow mineral were noticed, which on being picked out and examined proved to be troilite. There are, however, minute fissures running through several portions of the metal.

Traces of the Widmannstättian figures may be detected upon a polished surface even without the aid of an acid, and when the iron has been etched by nitric acid the markings are exceedingly distinct and beautiful, fully as much so as in any specimen of meteoric iron I have ever seen. The general appearance is a good deal like that of the iron from Lenarto in Hungary, and some of the Mexican specimens. In the mass No. 1, upon the principal cut surface, narrow, well-defined bands of alternate nickel-iron and Schreibersite are parallel or intersect each other at angles of about 60° and 120°; in the figures on the principal surface of No. 2, the angles of intersection more nearly approach 90°; on the much smaller cut surface of No. 3, the figures are somewhat more irregular, but the angles approach 60°. By etching surfaces obtained in other planes it was rendered evident that the difference of appearance is merely due to looking at different projections of the same crystalline structure. The accompanying engravings, taken from photographs, exhibit the results of etching these specimens.

The metal soon rusts upon cut surfaces, especially where the exudation of chlorine occurs, and this renders more distinctly visible the slight fissures which penetrate the interior.

No. 1.

No. 2.

No. 3.

The iron is not passive, though very easily rendered so by nitric acid. It reduces copper rather slowly from the sulphate, and if the whole surface be covered by the latter metal and then washed under a stream of water, rubbing hard with the hand or a cloth, a part of the copper comes off very easily, leaving the remainder firmly attached and reproducing very beautifully the Widmannstättian figures; obviously a case of galvanic deposition, the Schreibersite being the electro-negative solid and receiving the coating of copper.

By the prolonged action of acid delicate white laminæ of Schreibersite are brought into view, which if completely detached are found to be flexible and strongly magnetic.

The following are the results of chemical analysis.

	No. 1.	No. 2.	No. 3.
Iron,	88·706	88·365	89·007
Nickel,	10·163	10·242	9·964
Cobalt,	·396	·428	·387
Copper,	·003	·004	·003
Tin,	·002	·002	·003
Manganese,	trace	----	trace
Phosphorus,	·341	·362	·375
Sulphur,	·019	·008	·026
Chlorine,	·003	·002	·004

	No. 1.	No. 2.	No. 3.
Carbon, ----------	·172	·185	·122
Silica, ----------	·067	·061	·056
	99·872	99·659	99·947

These numbers are so closely accordant that there can be no doubt of the masses being essentially identical in chemical composition.

The nickel and iron were separated, in a cold and quite dilute solution, by means of carbonate of baryta, and the precipitates obtained were carefully tested as to purity before the weights were finally accepted as correct.

Considerable quantities of material were used for the determination of the minor constituents. Particular attention was given to the identification of the minute quantity of tin present, as Professor J. Lawrence Smith has lately mentioned* the fact, that he has never found this metal in the course of numerous analyses of meteoric iron. The precipitate with sulphuretted hydrogen, which contained the tin and copper, was in each case obtained from a solution of more than a hundred grams of the iron.

I feel satisfied that the chlorine is not of meteoric origin—not an essential constituent of the original masses—but has been derived from the soil in which the iron has lain imbedded. The exudation of watery drops containing metallic chlorides is observable only at points on the outside and on cut surfaces along the lines of fissures communicating with the outside. Although chlorine is mentioned above as found in the general analysis of the planing machine shavings, I failed altogether to detect it in a specially selected solid piece of some fifty grams taken from a part of No. 1 destitute of fissures or flaws.

The siliceous residue is set down as silicic acid, but some of it seems to have in reality existed as silicide of iron. A part of this residue having been examined with the blowpipe to identify it as silicic acid, another portion was looked at with a magnifying power of 250 to 500 diameters, and in polarized light was seen to consist of an amorphous powder, and rounded, transparent grains of very small dimensions, for the most part from ·0025 to ·0100 millimeter in diameter, of well-marked doubly refracting character.

It seems in the highest degree probable that these three masses of meteoric iron represent portions of a single fall from the heavens, agreeing so closely as they do in external character and appearance, in density and internal structure, and in chemical constitution; having, moreover, all been found at but short distances from each other. The precise localities from which they came are as follows:

* This Journal, II, xlix, 333, (May, 1870).

No. 1, from a spot on the land of Mr. Robert Van Lear, about five miles (a little East of) North from Staunton, in 38° 14′ N. lat. and 79° 01′ W. long.

No. 2, from the land of Mr. M. Fackler, about one mile to the Southeast of the locality of No. 1.

No. 3, about half a mile still further Southeast, or rather a little North of a N.W. and S.E. line passing through the last named locality.

It will be interesting to watch for the possible detection of other masses in the same neighborhood.

This makes the fourth recorded instance of meteorites found within the State of Virginia, the three preceding having been,

1. Meteoric stone, which fell in Chesterfield Co., June 4th, 1828, (this Jour. I, xv, 195 and xvi, 191).

2. Meteoric iron, found in Grayson Co., described by Prof. Rogers of this University in 1842, (this Jour., I, xliii, 169).

3. Meteoric iron, found in Roanoke Co., and described by Prof. Rogers in 1842, (this Jour., I, xliii, 169).

University of Virginia, March 27, 1871.

ART. III.—*The Glacial Features of Green Bay of Lake Michigan, with some observations on a probable former outlet of Lake Superior;* by N. H. WINCHELL, of the Geological Corps of Michigan.

THE topographical features of the region of Green Bay, are strikingly dependent on the geological structure as acted on by glacial forces. The west coast is low, and in but few places can the underlying rock be seen above the drift deposits. The immediate shore varies but little from the regular trend of the outcropping Trenton limestone. But two considerable bends occur on the west coast; and they are caused by alluvial deposits at the mouths of the Peshtigo and Menominee rivers. Across these rivers the bearing of the Trenton limestone is disclosed in the rapids which occur a few miles above their mouths. At the mouth of Little Bay de Noc the course of the coast line takes a direction nearly N. and S., an interesting fact, the special significance of which will be noticed further on.

The east coast is in the same way dependent on the line of bearing of the Niagara limestone; but, very unlike the west coast, it is frequently indented by bays which by their great depth of water form beautiful ship harbors. Of these Sturgeon Bay is the most remarkable, and may be taken as a type of all the deep indentures occurring on the east shore of Green Bay. The vast escarpment of Niagara limestone rises sometimes

immediately from the water, but more frequently it passes a short distance from the shore, forming an almost continuous rock-barrier 150 to 200 feet in height from the head of Great Bay de Noc to near the south end of Green Bay. It also underlies the whole table-land of the peninsula which encloses Green Bay, and affords by its natural dip a gentle descent E.S.E. toward Lake Michigan. Hence the entire drainage of the peninsula is into that lake, the "divide" being along the shore of Green Bay. The east and west shores afford another noticeable contrast in the comparative depth of the off-shore water. By inspecting the charts of the U. S. Lake Survey the recorded soundings along the west side show very shoal water, while on the east side the "ten-fathom line" runs near the land, frequently uniting with the shore-line, the entrances to the little bays being uniformly very deep. The passage through Port des Morts is 21 fathoms, north of Louse island 24 fathoms. The mouth of Eagle harbor is 11 fathoms, of Ellison's bay 12 fathoms, and of Hedgehog harbor 17 fathoms. The average depth of Green Bay is 16 to 18 fathoms.

The uniformity in the direction of these bays is another remarkable fact. They indent the peninsula in a southerly or southeasterly direction. On the contrary the bays on the opposite side of the peninsula, and opening into Lake Michigan, have a very uniform direction northerly or northwesterly, complementing those opening into Green Bay in such a way, that the peninsula is in several cases almost intersected by their near inosculation.

The barrier of the Niagara limestone is broken through at each of these bays, and its broken off ends form perpendicular and bald bluffs which face each other across their entrances, and rise to the height of 75 to 175 feet. Government and Hibbard's bluffs enclose Sturgeon bay. The former has a height of 115 feet, the latter about 80 feet. Eagle Bluff is on the south side of Eagle harbor and has a height of 149 feet 10 inches. Its counterpart on the north side is about 60 feet. Garden Bay in Great bay de Noc is another example of the same phenomenon. The Niagara barrier is more broken down between Port des Morts and Pt. de Morts and Pt. de Tour than at any other place. Projecting southward, the peninsula which encloses Great bay de Noc and terminates with Pt. de Tour, is a counterpart of that which encloses Green Bay; and the whole interval between Door Bluff on the south and Sag Bluff in Great bay de Noc on the north, is but an enlarged illustration of the phenomena already described. In this case the Niagara limestone is so completely broken down as to admit the waters of Lake Michigan, the Potawatamie islands, which lie in that interval, being its only parts remaining above the level of the lake.

Glacial striæ and polished surfaces at the head of Green Bay have a direction N. 34° E. coinciding with the axis of Green Bay. In the bay north of Sag and Burnt Bluffs, in Great Bay de Noc, they run about N.W. and S.E.

Among the glacial features may be mentioned the general aspect of the east shore of Green Bay and of Great Bay de Noc. Those deeply cut bays before mentioned must be regarded as of the nature of fiords, and doubtless owe their origin to spurs from the main glacier which excavated the Green Bay valley. The Sturgeon Bay spur was probably aided in taking its more easterly trend by a local glacier which contemporaneously descended the valley of the Uenominee. By their uniformity of direction a tendency is indicated in the main glacier to move in a more southerly direction than the general direction of Green Bay requires. In fact the islands between Port des Morts and Pt. de Tour exhibit the effect of intense glacier action in a direction N. and S. Long trails of detritus from these islands shoal the water for several miles southward; but toward the north the water becomes suddenly very deep.

A natural result of this spurring off from the main glacier is exhibited in the westward tendency of the coast line immediately south of the bays thus formed. The diversion of that portion of the moving glacier which passed through the valley of Sturgeon Bay would allow the extension of the opposing barrier of the Niagara limestone farther toward the west, thus bringing into view lower formations (Clinton and Cincinnati); and the spur which excavated Eagle harbor, acted in the same way to permit the existence of the point just west from the harbor on which the Clinton limestone is again exposed.

Another evidence of the more southward tendency of the main glacier consists in the fact that it actually broke through the Niagara barrier in numerous instances in a southerly direction, but did not once encroach upon the Trenton, on the opposite side of Green Bay, although it hardly rises above the water level.

We may therefore regard the fact established that the local glacier which excavated the valley of Green Bay, as far south as to include lakes Winnebago and Horicon in Wisconsin, was deflected from its N. and S. course by the escarpment of the Niagara limestone; and we must infer that its greatest force was felt where it first encountered it. We see the escarpment most demolished between Port des Morts and Pt. de Tour, and conclude that that interval must lie in the course of the original glacier. A course nothward thence carries us up the valley of Little Bay de Noc and the Whitefish river to the shore of Lake Superior. If we examine the south shore of Lake Superior,

we find that in a line directly north from the head of Little Bay de Noc occurs the only break in the otherwise continuous rock barrier. Dr. D. Houghton, in his report to the Michigan Legislature in 1840, says that "an elevated range of hills," or in another place, "an elevated and very regular chain of hills stretches from Point Iroquois to the Pictured Rocks," from which place they "pass away from the shore southwesterly," and Dr. Houghton adds that "the western prolongation of this rock has not been determined." From the mouth of the Chocolate river, six or eight miles east of Marquette, to a point one-and-a-half miles east of the mouth of Train river, the shore is low and occupied with drift deposits, the usual rocky barrier of sandstone is interrupted and entirely wanting. Both to the east and to the west from this interval the shore of the lake is formed by the rocky rampart either of the Lake Superior sandstone on the east, or of the Huronian and other Eozoic rocks on the west. Although this barrier passes a few miles away from the shore east of the Pictured Rocks it is nevertheless a continuous barrier of "sandstone hills" which cause the Falls of the Taquomenon, 90 feet in height, and appear in precipitous cliffs at or near Iroquois Point.

Again, from the mouth of Chocolate river to the falls of the upper Menominee occurs, in general, the strike of the Huronian, and from the latter place to the head of Keweenaw bay, a right line would pass some of the highest primary knobs and through the head waters of some of the principal rivers of the Upper Peninsula of Michigan. This rough and elevated character continues westward to the Montreal river, near the western extremity of Lake Superior. It is therefore rendered probable that the last lingering glacier, which was able to prolong itself beyond the south shore of Lake Superior, passed through the gap which occurs north from the head of Little Bay de Noc. It has been repeatedly stated by geologists who have observed the glacial striæ about Lake Superior, that their general direction is N.E. and S.W. It is therefore a fact of special significance, that the grooves at and near the mouth of Chocolate river show a north and south direction. At a point two miles west of the mouth of Carp river, and a few miles east of Marquette, there are two systems of glacial grooves, one running north 55° east, and the other north 5° east. Mr. Desor says of these: "The latter are distinctly seen crossing the others, and are therefore more recent. Some of them are besides distinctly curved, as if the body which produced them had been deflected in ascending the slope, a peculiarity not yet observed elsewhere." On an island east of Dead river (near Marquette) there are also two systems of furrows, one running N. and S. and one N. 20° E., the latter being the more distinct

and sometimes taking the form of troughs four feet wide and two feet deep.* These indicate that the continental glacier moved in a direction N.E. and S.W., forming the deepest furrows, but that the local glacier passed N. and S. It was also, doubtless, "deflected" from its course, and the opposition of the Huronian formation, which gives the coast great elevation and abruptly turns it north from this place, may be supposed to have caused that change in direction.

In relation to the country between the head of Little Bay de Noc and the shore of Lake Superior we may infer that a valley exists, or did exist when the glacial epoch was waning, connecting Lake Superior with Lake Michigan through Little Bay de Noc, and that the present outlet of Lake Superior is of comparatively recent date. Not only do the descriptions of this tract by Messrs. Foster and Whitney confirm that inference, but examinations made the present summer, by Mr. A. S. Wadsworth of the Michigan Geological Survey, almost directly demonstrate the former outlet of Lake Superior to have been through the Whitefish valley. There is a continuous valley with high drift banks uninterrupted, from the mouth of the Whitefish river to Lake Superior. Upon reaching the water-shed which lies but little above Lake Superior and within twelve miles of the mouth of the Train river, the head waters of the two rivers interlock on an extensive flat and rocky bed from which the drift has been removed and piled up in continuous bluffs on either side. From the summit of these bluffs extend extensive "pine plains," toward the east and west. On this rocky bottom are traces of running water, spread over an area of many acres, consisting of the peculiar "pot holes," from which "many cords of rock" have been removed. There are also deep gorges and crevices worn smooth by the motion of water and drifting sand.

Thus it appears that not only was the outlet of Lake Superior through Little Bay de Noc up to the close of the Tertiary, but that it continued to exist there after the stratification of the drift. The curious excavation and piling up of the drift on either side of the Whitefish valley could only have been done since the deposit of the same, and the water-worn surface of the Trenton limestone, on the top of the water-shed, must have been produced since the dawn of the Terrace Epoch. The old Tertiary channel is still obscured by the drift, either to the east or west of the channel discovered by Mr. Wadsworth.

Ann Arbor, Mich., August 20, 1870.

* Foster and Whitney's Report on L. Superior, Part I, p. 205.

ART. IV.—*Infusorial Circuit of Generations;* by THEOD. C. HILGARD.

THE soft and "naked," transparent and really animal* forms here to be considered, have some very striking and peculiar features in common. Their bodies are delicate, transparent, gelatinous, granular, and evidently *sexless*, although studded with reproductive yolks and locomotive molecules of the most varied description. On contact with air, when drying up, they do not leave behind any coherent coat or tissue whatever; but so soon as they are affected by incipient exsiccation, at once, by some sudden internal commotion, as if *melting* away, they become *liquid*, and entirely dissolve into a "sauce" of quite uniform, hyaline molecules, about $\frac{1}{2000}$ line in diameter. They are all evidently *immature* forms, subject to a vast cycle of progressive and retrograde developments and infinitely multiplying the molecular germs at every individual dissolution.† A little salt, glycerine, or sugar destroys their present form; but they seem to be hardly affected by morphia or atropia, even in strong solutions.

It is this feature of the *non-endurance in drying up*, which renders it at once certain, that no such sarcode bodies can continue to exist *in integro*, when exposed to the full heat of summer, on a cracking dry tub, or on a roof, likewise as torrid as a blazing July sun can render it within four weeks. The same applies to all the confervaceous, palmellaceous, protococcous, desmidiaceous, etc., fresh-water spawns, of true Mosses; which, once collapsed by drought, rarely continue growth in a progressive sense. With the exception of their *common* "nostoc"-phase‡ (specially adapted to endure even excessive dryness) they

* i. e. exclusive of all the chlorophyll-endowed, silica-coated, and automatous, or cellular cell-like sarcodic bodies and also the clear and vibrionic forms which belong to the algoid *bryaceous developments*. They are partly classed as green "Infusoria," and also constitute the "Chlorospermeæ" of "Algæ."

† The same doubtless applies to a small "Stentor Roe," seen hovering up and down in water taken from ponds, aquaria, etc. It is of a hazy white color, scarcely perceptible to the naked eye, and remarkable for never touching the surface. When placed under the microscope, in a drop exposed to air, this animal germ (in shape resembling a Cyprea or a coffee bean) is seen violently throwing open its "cloak" or mantle, exhibiting an intense ciliary (*fingered*) vibratory action, *all over the interior surface*. It then throws out hyaline constitutive brood-balls of various sizes, *each endowed with the same "fingered" action*—(as if "kneaded about" in invisible hands)—and ultimately entirely *flows apart into such fleshy cilia*, only leaving the *intestine* behind.

‡ This form of self-multiplying, serial chorophyll bead-strings enveloped in a foliaceous slime is common to Lichens (particularly the genus Collema) and various brooding-phases of the algoid (*chlorospermous*) moss-spawns. With the Lichens, the internal chlorophyll of their thallus often develops, as is well known, in similar bead-strings, borne on the end of colorless (fungoid) tissue-fibers; in a manner also represented in the anatomy of *Blodgettia confervoides*, in Harvey's "Nereïs."

"revive" *only* by starting anew from very reduced, but immensely multitudinous *constituent particles of their own*, which perdure exsiccation. In the class of Fungi we meet with similar examples, as e. g. in the case of the yeast-plant, which can endure a considerable degree of exsiccation without impairing the vitality of those cell-*contents*, which actually exercise the fermentive energies and also consume the old cell-coat—(*not* common cellulose, by the way) in this process of reviving. Likewise, the vermillion, gummose (*tubercularia*) pimples on rotting Black Oak branches can endure a baking process in the burning sun, but still revive on contact with water. Its spicular "spermatia" (*fusidium*, resembling Naviculæ or magnetic needles) at once assume an oscillatory motion and swell up to the size of those didymous (*trichothecium*) spores which presently stand erect on pedicels, as a pink velvet, in the chinks of the bark and collapse at the first touch of the sun; while their ultimate subcortical development into a mature, "black enamel" Sphæria again perdures in the heat.

Under the circumstances above mentioned, the rain water and dry dust carried by the wind to the roof, and thence collected into a perfectly dry tub, itself standing on a similar roof, within a few days was found swarming with all the minor phases of the Vorticello-planarian germ-developments. Both the bodies and the yolks or gemmæ of the latter occasionally become reduced, by spontaneous dissolution, into very minute particles, each in the *wet* state capable of resuming the regeneration of individual germs. Judging from analogy, it is but reasonable to suppose, that it is this reduced nubecular and molecular condition, which adapts them to last and survive in a *dry* condition, as we find it not only with the Fungi, but also in the case of the pruinose-pulverulent, primitive moss-spawns, all three agreeing in this feature of being "reduced to dust," out of which they are again resuscitated. This evanescent condition, however, where gelatinous particles of about $\frac{1}{2\,0\,0\,0}$ of a line diameter shrink alike to imperceptible dimensions, affords no pretext whatever for assuming identities, just because we ourselves lose the *means of discrimination*. Whenever the identity of *substance* is preserved, each of these various molecular organisms preserves its cyclar developments distinct from similar, corresponding ones as true species, so far as my observations go.

There being, at present, no comprehensive pictorial works available to fall back upon for reference, that are sufficiently correct, even in their designs, to identify the forms, allowance must be made for the liberties of comparison taken in the following descriptive representation of the most frequent infusorial processes.

On extensive clay formations, all over the central part of the Mississippi valley, the first appearance, in the warm season, of vegetable life, e. g. in water-pools recently formed by rain, etc., is mainly that of "Chlamydococcus pluvialis," even where the clay is immediately taken from the deepest excavations. As the sequel of my papers will show, this particular form belongs to the common Silver-moss (*Bryum argenteum*) which is widely disseminated all over the surface of the globe, and that, by the way, rather scantily "fructifies" in a "sexual" fashion, i. e. by the development of a *theca;* but on clayey soils fills all the sluggish and stagnant waters with its virescent uliginous spawns; while it covers the surface of fields, by millions of acres, with a minute crust, or "*brick red leprosy,*"* whose fine, molecular dust is swept aloft by every wind. Immediately before the frost, the same fields are densely covered with a small crop of minute moss, doomed to perish in this form, but revived in its spawns at the first thaw in the shape of a universal *chalk-white* "*clay-bloom,*" or pruinose efflorescence from the soil, and that in water at once re-develops into the so-called *Protococcus* (or *Chlamydococcus*) *pluvialis* in the form of green flagellate-roving beads.

These minute, but in this instance *coated*, swarming cells are replete with chlorophyll, and are globular ovoid in shape. They have at their smaller end, just where the motor *flagellum* (or vibratory lash) arises, a clear point of substance; wherein, in a small percentage of these cells, *a parasite* is found to develop.

This parasite is a perfectly colorless globule, apparent in the clear navel-point of the cell, and exhibits a faintly opalescent hue. As it grows, the cell which harbors the "*incubus*" loses its own individual vitality. It ceases to swarm about and dissect into living, chlorophylliferous and automatous progenies, as the live ones do. Instead of spontaneously dissolving as in the living process the cell-coat remains firm; and as the parasitic animal yolk grows and occupies more space, executing tremulous and vibratory contractions, the chlorophyll is pressed into the rear, a lifeless mass. At last the cell is ruptured in

* See St. Louis Med. Reporter, Jan. 1st, 1867, pp. 522, 527—528. Also Proc. St. Louis Ac. Sc. (July, 1861), vol. ii, No. 1, p. 160; and vol. i, p. 156. For "Chlorococcum" read "*Sphærocarpus*" (lately renamed "*Protuberans*" Ag.) and its "botrydium" progenies. The latter collapse and turn red. This pulverulent, *miniate* "*Lepraria kermesina*" Auct., must, however, by no means be confounded with the darkly purpureous, uliginous moss-spawns which cover, e. g. the hilly "Orange-sand" regions of the State of Mississippi. It is prevalent in winter in damp weather, and consists of matted red "Microcoleus" or lumbricoid (sheathing) moss-cells, each one containing a central brood-fiber which is medullary-dotted, dissecting, and fascicularly surrounded by a stratum of (automatous, prorepent) "Oscillaria"-fibrils. Not only the ultimately enlarged (chlorophylliferous) brood-segments, but also the dark undulating fiber, form brood-balls (terminally). Its gelatine forms a cement of the loose sandy clay, and a home or abode for the Cladoniae (or bright-green foliolate lichens) as well as for grasses, etc.

front, and the cupular-compressed, dead, chlorophylline mass remains inert and void of life until devoured by Infusoria or the zymotic fungus. The cell-coat, likewise, is effete, while the large globular and somewhat acicularly-granulated incubus, after a few very wry contractions, at once widely opens a large, ciliate mouth, gaping across the sphere's surface; and disengaging or displaying a girdle of cilia round the rear part of the body, it immediately represents the *free-roving Vorticella* in full equipment.

Its subsequent "encystment," into a spherical cyst *densely covered with short prickles* (somewhat like the rim of a Heliopelta) and containing entrail-like designs, is well known.* Also, that it eventually bursts—*occasionally*, at least—and disgorges a peculiar sort of *wafer*-shaped, elliptical (not ellipsoidal!) cells, or nuclei, whose ulterior fate and abode, however, hitherto remained unknown.

The fact is, that they rise to the *surface*, where, on account of their shape, they *inhere*, as an almost imperceptible pellicle or stratum, which to the microscopic observer is the instantaneous index of the precise *focality* of the surface.

In this state, when no food is supplied, they long remain unaltered. When meat, bread or other nutritive matter is added, however, they *develop* (particularly where the absence of light prevents the confervaceous or green, chlorophylline growths from becoming paramount) into the smallest *Vorticellæ*. The center of the wafer-shaped disc, inherent in the denser surface of the water, protrudes downward into a little clear knoll or navel, which soon begins to *jerk*, representing as it were a pin-head of $\frac{1}{100}$ line diameter on a little thread or coiled stalk; and, as the whole increases in size, it now constitutes the well-known *spirally pedunculate* Vorticella; pyriform-bell shaped, somewhat pitcher-mouthed, with cilia around the orifice and a clear granular *nucleus* or "germinal speck" inside.

The multiplication of the pedunculate Vorticellæ, by fission, lengthwise, and by budding-out, sideways, at the rear end, is sufficiently known. As the bud tears loose, there is yet no oral aperture visible. There is, however, a girdle of cilia at the *rear*, wherewith it performs an undulatory vibration, until it tears loose by spinning round; and after irregularly prancing about, and rebounding at head-long speed, within a few minutes it "settles" upon some suitable surface, with the ciliated rear end; and spinning out a *podetium*, or peduncle, often within a quarter of an hour, the rear cilia get applied downward to the body and disappear; while after a little time a fully ciliated mouth now opens *in front*.

* In fig. 215, Carp. "Micr." (p. 446), the short prickles are omitted, B. to E.

As for its *retrograde* multiplications, when a Vorticella gets "sick," for want of air or food (as when kept between glass-plates held apart and glued round about, or cemented, to prevent evaporation), the body contracts to a perfect globe, with a big germinal point, "eye" or nucleus in the middle; the throat contracted, and the lifeless cilia standing around like the limb of a rose-calyx. The germinal speck, ogle or nucleus soon becomes immensely bloated, protruding out of the crown or ciliate aperture like a dim, hazy *balloon*, and then being either suddenly or gradually exploded, its almost invisible granular contents settle around and increase into a rather densely *punctuated cloud*, run up like a *cumulus;* its tips mostly warty as with (dotted) strawberries, a sort of primordial "framboësia." It is to this form that I wish to call particular attention, since it presents *the most minute phase of individual animate life* visible at represent under the known powers of the microscope: being the ultimate retrograde development-phase, as well as the first manifestation, common to all such soft primitive *sarcode* bodies, from the "Vorticellan" to the most bulky "Paramecian" forms. And from each little dot in these "clouds of life" a separate Vorticella can be seen to develop! It is here, indeed, at this first *visible* advent or exordium of animate life, and the resurrection of millions of germs through the spontaneous dissolution of a single one, that the last nubecular *microscopic* perceptions closely resemble the last nebular telescopic as well as the *theoretic* ones of Laplace's cosmogony.

For the present let us call such often repeated forms of retrograde self-dissolution and self-multiplication a germinal *nubecula.* Such likewise occur in a very closely analogous form in the self-maceration (of the engulfed pencil-beads and the enlarged "oidium"-joints) of the yeast or "zymotic" fungus. The difference being, that in the case of *animal* infusoria the dots remain affixed, and, after jerking apart, rapidly travel on separately with a vaccillating motion resulting from their warped surface (*true* Zooglœa Termo *Cohn; not* that of *Klob*), while in the case of the mucous or polypoid fungine diffluence (erroneously called by the above name by *Klob*), the component blunt-cylindrical Cacteria are not mutually fixed, but all simultaneously slowly move onward and apart in slimy *trails*, without a perceptible rotation, simply quivering, and ultimately enlarge into fibers. Of the *black* or "indissoluble" nebula-form of the zymotic or yeast-fungus I have already treated in the St. Louis Medical Reporter, Jan. 1st, 1868, (Zymotic Condition, etc.) and Proc. A. A. A. S., 1870, *et ante.* Neither the animal molecules nor the (coated) "Cacteria" join into file, as do the fermentic sarcode-vibrios, being *naked.*

The watchful observer will have opportunity of witnessing

another sort of "fertile dissolution," of the more bulky Vorticellæ, by the discharge of certain globular, granular "pellets," surrounded with other adhering and *jerking* particles—(probably the "acineta" of some authors)—while containing the "currant-shaped" yolks,—hereafter to be described, together with its "amœba" or pseudopodial dissolution, when treating of the so-called "*Paramecium Aurelia.*"

[To be continued.]

ART. V.—*On the application of Photography to the determination of Astronomical data;* by ASAPH HALL.*

ANY one who has witnessed a total eclipse of the sun must have felt his utter inability to make a correct description of the various features of the phenomenon, and must have wished for some means by which all these features, so suddenly and so grandly displayed, might be portrayed impartially and truthfully and in such a way that they could be subjected to a cool and leisurely examination. Such a means is furnished in a good degree by photography. A few photographs of the corona and protuberances of a total eclipse are far more trustworthy than all the hand sketches that have ever been made. It is true indeed that by the union of several observers and each one giving his attention to some specific point much may be learned, and some things perhaps that photography is not yet able to exhibit, but speaking generally we may say that photography combines the powers of all these observers and furnishes a record admirable for its truthfulness. Photography combines the powers of all these observers and furnishes a record admirable for its truthfulness. The beautiful photographs of the solar eclipse of Aug. 1869 obtained by Prof. Morton and Dr. Curtis, and those of the eclipse of 1870 by the English and American parties in Spain and Sicily attest the truth of this assertion; and the photographs of the moon by Messrs. Draper, Rutherfurd and De la Rue also give ample evidence of the value of photography when applied to descriptive astronomy. But that photography gives us the means for the exact measurement of angles and distances and thus of determining accurate astronomical data in the case of a solar eclipse or of a transit of a planet does not yet appear to be clearly established. In the hope of provoking discussion and investigation of the subject a brief review of what has been done in this application of the photographic method seems opportune, especially so, considering the extensive use that may be made of the method in observing the transit of Venus now near at hand.

* Read before the Washington Philosophical Society.

The first photographs of double stars, made for the purpose of determining by micrometric measurement their relative angle of position and distance, were those of Mizar and its companion, made at the Harvard College Observatory in April and May, 1857, by Messrs. Whipple and Black of Boston. Professor G. P. Bond has given in the Astronomische Nachrichten, No. 1105, the results of his measurements of the thirteen photographic images. The zero of the angle of position was found by moving the telescope in right ascension after an impression had been taken and taking a second one on the same plate. This process repeated gave a series of photographic images on the same plate and the right line passing through the series gave the direction of the daily motion of the heavens. The probable error of a single measurement of the photographic distance of the images was found to be $\pm$ 0·″12, or somewhat smaller than that of a direct measurement with the common filar micrometer. During the summer of 1857 many more photographs of this double star were taken, and in the journal above mentioned, No. 1129, Prof. Bond has given an elaborate account of the measurement of sixty-two photographic images. For this measurement of these images a new and improved micrometer was employed, consisting of an achromatic microscope with a magnifying power of 2200. Under this microscope the star images appeared as aggregations of minute drops of matter and looked like the result of a great number of vibrating and momentary impressions. They were generally symmetrical with a gradual condensation toward the center of the image, and the bisection of an image with the wire of the micrometer could be done with great exactness. The probable error of the center of an image was found to be $\pm$0·″051, and hence that of the distance of two such centers to be $\pm$0·″072. Adopting the estimate of Struve, $\pm$0·″127, as the probable error of a single measurement of a double star of this class with a filar micrometer, the measurement of the photographic images would have a relative value three times greater, or $= (\frac{9}{8}\cdot\frac{1}{6}\frac{2}{7}\frac{7}{2})$. The accuracy of the measurement is better shown by the numerical results obtained by Prof. Bond, which are as follows:

Mean Exposure.	Distance.	No. of images.
13^s	14″·31 $\pm$ 0·034	7
16	14 ·19 $\pm$ 0·035	7
18	14 ·18 $\pm$ 0·033	8
24	14 ·23 $\pm$ 0·035	8
25	14 ·15 $\pm$ 0·034	7
30	14 ·28 $\pm$ 0·034	7
33	14 ·19 $\pm$ 0·033	8
36	14 ·20 $\pm$ 0·032	10
24·5	14 ·21 $\pm$ 0·013	62

The application by Prof. Bond of photography to stellar astronomy was confined to stars brighter than the seventh magnitude, and with the hope probably of finding some encouragement of obtaining photographs of much fainter stars, he has discussed very fully in the Astronomische Nachrichten, No. 1158 and 1159, the effect of increasing the times of exposure of the photographic plates. The result which he arrives at is that "deficiency of light can be more than compensated for by a proportionate increase in the time of exposure;" and concludes that an exposure of ten minutes with the Cambridge Equatorial would give a photographic image of a star of the ninth magnitude. This, however, appears to be a question that can be decided only by actual experiment.

The last essay referred to closes Prof. Bond's work in stellar photography. He intended to resume the subject and was confident of being able to make photographic images of stars down to the ninth magnitude, but failing health and a desire to finish his work on the great nebula in Orion prevented him from undertaking any further experiments. Having participated in the work of measuring the photographic images and in reducing the measurements, and having a vivid remembrance of the labor performed, I take the liberty of stating my own estimate of the two methods of observing double stars, viz: the photographic method and that of direct measurement with a filar micrometer or heliometer. In the case of double and triple stars I have no doubt that the better method is that of direct measurement. The labor of setting the circles and finding the star is common to both methods, but during the time required to adjust properly the clock work and make a series of photographic images a practised observer would make and reduce a series of direct measurements. It is thus possible by the direct method more easily to repeat the observation under varied conditions of atmosphere, observer and instrument, and in this way to render the final result less liable to systematic errors. It is true that according to Prof. Bond's calculations, the photographic method is decidedly the more accurate, but some experience makes one, I think, distrustful of inferences drawn from the values of probable errors. The most dangerous errors of observation are those that are constant or systematic, and these the theory of probability does not and can not recognize. It is this class of errors which is the source of the large discordances frequently seen in different determinations of the same quantity while each single determination has apparently a very small probable error. It should therefore be the care of the observer to vary the circumstances of his observation in order to avoid systematic error, or to give it as much as possible the nature of those irregular errors which in the long run tend to eliminate themselves. Finally, it may be stated as a general

rule that, other things being equal, the simpler and more direct the method of observing, the better. In order to justify the interposition of any new process it must be shown that this process gives greater accuracy or greater rapidity of observing or both. Thus the chronographic method of observing transits is justified on the ground that it gives greater ease and rapidity of observing, since the gain in accuracy is scarcely sensible.

In the case of groups of stars like the Pleiades or Præsepe there would be a great advantage in using the photographic method provided the plates could be made sufficiently sensitive, so that images of stars of the ninth and tenth magnitudes could be obtained. Mr. Rutherfurd, who has done so much in astronomical photography, has made photographs of both the groups mentioned, and from his plates Dr. B. A. Gould has deduced positions of the stars. Dr. Gould's memoir on the Pleiades was presented to the National Academy five years ago, and it is to be regretted that it is not yet published.

The first application of photography to determine the times of contact in a solar eclipse was made by Mr. Warren De la Rue in the case of the eclipse of July, 1860. In the Philosophical Transactions, of the Royal Society of London, 1862, Mr. De la Rue has given a full account of his work, together with an engraving and description of the micrometer employed for measuring the photographs. The Kew heliograph was used in obtaining the photographs, an instrument designed by Mr. De la Rue for the purpose of making photographs of the Sun's disk. By means of a Huyghenian eye-piece the image of the sun was enlarged to a diameter of nearly four inches. Two position wires at right angles to each other were placed in the focus of the eye-piece at an angle of nearly 45° to a parallel of declination, and the final correction to the position of these wires was found by observing transits of the sun's limbs after the method proposed by Mr. Carrington. The wires being photographed on the plates their images furnished a means of finding the zero of position, and the plates were measured for the position angles of the cusps and their chords, also the radii of the sun and moon and the positions of their centers. By comparing the interval of time of two consecutive photographs with the measured position of the centers, the relative motion of the sun and moon was deduced and hence the times of contact which agree tolerably well with each other, but not so well perhaps as those of the ordinary direct observation. The value in arc of a single division of the measuring scale was found by measuring on the plates the radius of the sun in parts of the scale and then assuming a value of the sun's radius. A very doubtful correction of $-4''.1$ is deduced for the sum of the semi-diameters of the sun and moon.

Mr. De la Rue speaks of having made some observations to determine whether in the process of drying the images had undergone any distortion, and says: "The result, however, proved that there was no appreciable contraction, except in thickness, and that the collodion film did not become distorted, provided the rims of the glass plates had been well ground." This point being a fundamental one appears worthy of further investigation. There is some uncertainty and vagueness about Mr. De la Rue's methods which do not give much confidence in the accuracy of his results, but on the whole he appears to have shown that the photographic method promises good results which is all perhaps that a first trial could be expected to do.

The next and last memoir published on this subject is that by Messrs. De la Rue, Balfour Stewart and Benjamin Loewy, on Solar Physics, Philosophical Transactions, 1869, giving an account of the positions and areas of the sun-spots observed with the Kew photoheliograph during the years 1862 and 1863. In order to determine the heliographical latitude and longitude of a spot two elements are required, viz: its angle of position and its distance from the sun's center at the time of observation. These elements were obtained by measuring the photographic plates, the position wires being similar to those used by Mr. De la Rue in the solar eclipse of 1860, and their zero being determined in the same manner. This memoir contains a large amount of interesting information concerning the position and areas of the solar spots, but the determinations of position are vitiated in some degree by the optical distortion of the instrument. The observers at Kew have made experiments to determine the amount of distortion, but no definitive result has yet been reached. They say that the following facts may be regarded as established: "1st, that the image of any object photographically depicted is liable to a distortion, which varies at different distances from the center of the field, and the amount of which may be determined for every instrument by methods similar to that employed by ourselves; 2d, that in our case the image of an object is larger when formed near the edge of the field than at the center, and that the amount of elongation of a unit of length at the center increases with its distance from the center." Their conclusion is that the inquiry is not sufficiently far advanced to justify any corrections of the positions of the spots on account of the effect of distortion, but they express the hope that at last they will be able to give thoroughly satisfactory constants for the effect of displacement in their instrument.

The photographs of the solar eclipse of August, 1869, have not yet been measured and discussed so far as I know, but it is pretty certain that all the images are affected by distortion which will in a measure render the results dependent and untrustworthy. It is to be hoped, however, that these pho-

tographic plates will be subjected to a careful examination in order that some estimate may be made of the extent of error to which they are liable. In the case of a solar eclipse, or of a transit of a planet over the sun's disk the photographic method has very great advantages over the observations of contact in many respects, and the errors to which it is subject are worthy of the most thorough investigation. The observation of a contact is uncertain on account of irradiation, and it is momentary also, so that if lost by a cloud, or in any way, the observer is compelled to view for several hours the phenomenon without being able to observe it. On the other hand when the sky is clear a photographic image can be obtained in an instant, and even if all the contacts be lost, valuable results might be secured if the readings of the photographic plates can be correctly reduced. Just here then is the point for experiment, investigation and invention, since it is most desirable that no doubt should remain as to the possibility of correctly measuring and reducing the photographic observations of the transit of Venus.

Mar. 25, 1871.

ART. VI.—*On Ralstonite, a new Fluoride from Arksut-Fiord;* by GEO. J. BRUSH.

THE recent exploitation of the Greenland cryolite has not only led to the discovery of crystallized cryolite, but has given to mineralogical science several new fluorides, two of which, thomsenolite and pachnolite, are found in beautiful crystallized forms.

I now call attention to another fluoride observed, a few months since, by Rev. J. Grier Ralston of Norristown, Pa. Mr. Ralston found a mineral in minute octahedrons associated with thomsenolite, and being unable to identify it, he sent it to Prof. Dana, by whom the specimens were passed over to me for examination.

The crystals of the new mineral are octahedral; and in some cases they are very minute, but occasionally one to one-and-a-half millimeters in diameter. They are often implanted on the thomsenolite crystals, and also apparently intercrystallized with this species, making it extremely difficult to separate the new mineral sufficiently pure for analysis. The planes of the octahedron are often tinged slightly yellow, and many of them are dull and iridiscent, owing to an excessively thin film of oxide of iron, and hence exact measurement of the inclinations of the faces cannot be made. But they appear to be symmetrical with equilateral faces, and, in some cases, have all the solid angles replaced by a minute plane. With so regular a habit and the

planes alike in lustre I cannot doubt that they are isometric octahedrons, and hence that the small plane on the angles is a cubic plane.

The mineral is colorless to white, with a vitreous luster, and has a hardness greater than fluorite, equal to about 4·5. Specific gravity, taken on 25 milligrams, gave 2·4.

In the closed tube the mineral whitens, yields water at first, then gives off fumes and a copious white sublimate, while the walls of the tube are etched. The vapor in the tube, as well as the water, reacts acid. Even at a very elevated temperature the heated fragment retains its original form and does not fuse. In the open tube the mineral gave similar reactions.

B.B. on charcoal a faint white sublimate was observed. In the platinum forceps the mineral whitens without fusion and colors the flame a soda-yellow; moistened with sulphuric acid this coloration was unchanged. Heated with cobalt solution in the platinum forceps the mineral assumed a bright alumina-blue. In salt of phosphorus the substance was readily dissolved, giving a colorless bead in both O. and R.F. In a soda bead it dissolved with effervescence.

The mineral was found on close examination with a magnifier to be so intimately associated with thomsenolite, that it was deemed impracticable to separate a sufficient quantity for any thing more than a preliminary qualitative examination in the wet way. A small portion, some 30 milligrams, selected with great care to ensure purity, was, decomposed in a platinum capsule by sulphuric acid. It gave off fluohydric acid, etching a glass plate, and on solution it gave with reagents a precipitate of alumina, with evidences of the presence of lime and soda. With the spectroscope, the pure mineral alone gave only the soda line, but when even a very minute speck of thomsenolite was associated with it, the lime line was very marked. The solution from which alumina was separated afforded on evaporation to dryness a minute residue, which, when examined with the spectroscope, gave both soda and lime lines.

It therefore appears that the mineral under examination is essentially a hydrous fluoride of aluminum with probably a small amount of calcium and sodium. Its isometric form, and its infusibility, distinguishes it from all other fluorides yet described as occurring at the cryolite locality in Greenland.

The only mineral which in general chemical characters approaches it is the fluellite from Stenna-Gwyn in Cornwall. This rare mineral, according to Wollaston, is a fluoride of aluminum, but it occurs in elongated orthorhombic octahedrons. These facts are, I think, sufficient to warrant the conclusion that the Greenland octahedral mineral is a new fluoride, and I propose for it the name *Ralstonite*, after its discoverer.

ART. VII.—*Notes on the Primordial Rocks in the vicinity of Troy, N. Y.;* by S. W. FORD.

IN view of the prevailing uncertainty respecting the age of the rocks of that portion of the Taconic series of Professor Emmons lying east of the Hudson river, I was led several years ago to undertake the investigation of some of these rocks in my own neighborhood, though I had but few hopes of learning anything essentially new about them. It soon became apparent that much valuable information might be obtained from them; and from certain facts which early came under my observation I was induced to continue their study. I propose here to notice briefly some of the more noteworthy results thus far obtained.

The rocks immediately east of the Hudson at Troy are fine black, glazed shales, with occasional sandy layers, and have usually been regarded as belonging to the Hudson River formation. They have been greatly crushed, but their general dip is evidently eastward, and at a high angle. They extend eastward about half a mile, and form a hill of considerable magnitude within the city limits. Following the course of this hill northward, we find them frequently well exposed in railway cuttings, and before reaching Lansingburgh, which is three miles distant, in a bold elevation several hundred feet in height.

The only fossils which these shales have afforded, are the obscure form described under the name of *Discophylum peltatum* (Pal. N. Y., vol. i, p. 277, plate lxxv, fig. 3), and two or three species of graptolites, the latter having been but recently obtained. The graptolites resemble closely certain well known Hudson river forms, but whether certainly identical I am at present unable to state. If truly Hudson river shales, then the absence of any other fossils in these rocks except those above mentioned appears not a little remarkable.

Upon the east, after an interval of concealment varying somewhat in different localities, these shales are followed by the widely different rocks of the "Taconic" series likewise dipping eastward, and apparently at about the same angle. The best exposures of these rocks in this vicinity occur opposite the central portion of the city, where they are brought to view in a number of abrupt, quickly concealed outcrops. These outcrops trend northerly and southerly, and appear to be all constructed upon the same pattern, having on the west a steep, on the east a more gradual slope. Only the western faces are naturally exposed. This uniformity of structure is very striking, and there are reasons for believing that it has resulted largely from successive short, sharp folds in the strata, of which we have a fine example in the rocks east of Lansingburgh; but as nearly

the whole district is covered with a thick sheet of drift, and the rocks bear evidence of extensive faulting, much further study will be necessary before it will be fully understood.

These outcrops generally consist for the most part of coarse red and yellow weathering slates and shales, with occasional thin-bedded sandstones; but the most of them are supposed, and four of them are known, to hold subordinate limestone deposits. Of these deposits the two western-most individually consist of a few courses of thick-bedded limestone, and of irregular, sometimes lenticular, sparry and frequently pebbly masses, varying from one to several hundred pounds in weight, imbedded in a coarse, dirty-looking arenaceous matrix; while the others form tolerably compact, even-bedded limestones, with an abundance of scattered black nodules, from twenty-five to thirty feet in thickness.

So far as investigated, these limestones have been found to be highly fossiliferous, though the fossils are usually in a very fragmentary condition. From two of them—one of the conglomerates and one of the even-bedded masses—the writer has made frequent collections during the last three years. With a single exception the same species occur in both. Up to the present time they have yielded eighteen species, which are distributed as follows:

Protozoa (*Archæocyathus*)	1	species.
Brachiopoda	7	"
Lamellibranchiata	1	"
Gasteropoda	1	"
Pteropoda (*Hyolithes*)	2	"
Annelida (*Salterella*)	1	"
Crustacea	5	"
Total,	18	"

Of these, six—*Obolella* (*Avicula?*) *desquamata* (Hall), *O.* (*Orbicula?*) *crassa* (H.), *O.* (*Orbicula*) *cælata* (H.), *Metoptomas rugosa* (H.), *Theca triangularis* (H.), and *Agnostus lobatus* (H.)—were figured and described in the first volume of the Paleontology of New York in 1843, from this locality; and two—*Conocephalus* (*Atops*) *trilineatus* (Emm.) and *Olenellus* (*Olenus*) *asaphoides* (H.), from Greenwich, Washington county. All the rest are new or undescribed.*

Desiring further information in regard to certain of these new species, I several months since wrote Mr. E. Billings, Paleontologist of the Geological Survey of Canada, at the same time giving him a list of the species in my possession from this

* Unless one of them should prove identical with the species of *Cypricardia* figured by Emmons (American Geology, p. 113, plate 1, fig. 1.)

quarter. In reply Mr. B. informed me that he was just then engaged upon a collection of new fossils from the Lower Potsdam formation below Quebec, which he strongly suspected to be identical with my own; and on comparison it was found that fifteen out of the eighteen species from Troy were held by us in common, and shown to be perfectly identical. Such an unlooked for result of course surprised us greatly. That the Lower Potsdam formation below Quebec, and the western portion of the Taconic series near Troy* are of the same age, there seems now but little room for doubt.

Two very characteristic fossils of this formation are the opercula of two species of *Hyolithes*, upon which I communicated a note in the preceding number of this Journal. One of them was there described as a "minute, circular species, with four pairs of lateral muscular impressions and two smaller, dorsal, all radiating from a point near one side;" the other as "larger, and like a *Discina* on the outside." The former occurs quite abundantly in the Troy limestones, and is a very beautiful little object. It varies in size from a mere point to a diameter of three lines. Perfect specimens have a rich, polished appearance. The other occurs more rarely. As might naturally be expected, these rocks contain immense numbers of *Hyolithes*. Indeed, large portions of the limestone are often almost wholly composed of them.

Without doubt this formation in New York will yet afford many new species. The even-bedded limestones east of Troy, to which especial attention has been given, as well as portions of the conglomerates, are literally loaded with fossils, and promise richly to repay investigation for a long time to come. Their associated slates, shales and sandstones have as yet afforded no fossils. Near Lansingburgh, however, where what is at present regarded as a lower member of the formation, consisting of heavy and thin-bedded gray sandstones with interstratified black slates, is exposed, a few obscure Fucoids have been found, but these rocks have been but imperfectly investigated. Neither the thickness nor precise eastern limit of this formation has yet been ascertained.

Troy, N. Y., May 24, 1871.

* These rocks have hitherto been referred, though with some doubt, to the Calciferous portion of the Quebec Group; but all modern investigations in our older strata have steadily pointed to their higher antiquity; and it is simply justice to state that, by several geologists besides those who have adopted Prof. Emmons' views of their age, this has long been suspected.

ART. VIII.—*Notice of some new Fossil Mammals from the Tertiary Formation;* by Professor O. C. MARSH of Yale College.

IN association with the Reptilian fossils collected by the Yale College party last summer, and already described in this Journal,* numerous remains of Mammals were also discovered, and in the following article some of the more interesting new species are briefly characterized. A few species from the other Tertiary lake-basins of the Rocky Mountains have been included, as they throw considerable light on the ancient sub-tropical fauna of that region. The present notice is merely preliminary to a full description, with illustrations, now in course of preparation.

Titanotherium? anceps, sp. nov.

The largest extinct mammal discovered by our party in the Green River basin was apparently one of the rarest; and the remains obtained, although in themselves characteristic, include, unfortunately, none of the teeth sufficiently well preserved to afford generic characters. The single species thus indicated has accordingly been referred, with a doubt, to the genus *Titanotherium*, seemingly a near ally, until the discovery of additional material clears up the question of its exact affinities.

The specimens discovered, which evidently pertained to three different individuals, mainly consist of several dorsal vertebræ, the distal end of a humerus, the greater portion of a tibia, and some of the smaller bones of the extremities. They indicate a Pachyderm, much larger than any other known mammal from the same deposits, and about two thirds the size of *Titanotherium Prouti*, from the Tertiary basin east of the Rocky Mountains. The anterior dorsal vertebræ preserved have both articular faces slightly concave, thus distinguishing the species at once from *T. Prouti*, which has in this part of the series the front vertebral face very convex, and the posterior face concave. Another marked difference is seen in the tibia, which at its proximal end has the femoral articular surfaces contiguous, with no prominent elevation between them, resembling in this respect some of the Proboscidea.

Measurements.

Length of anterior dorsal vertebra, on lower surface,	2	inches	2	lines.
Width of posterior face between rib cavities,	3	"		
Height of posterior face,	2	"	5	"
Transverse diameter of tibia at proximal end,	4	"	10	"
Fore and aft diameter,	4	"	3	"
Transverse diameter at distal end,	3	"	11	"
Fore and aft diameter,	3	"	3	"

* Vol. i, 1871, pp. 192, 322, and 447.

The remains were found by Lieut. Wann, and the writer, in the "Mauvaises Terres" deposits, near Sage Creek, Western Wyoming. The geological horizon is lower Miocene, or perhaps Eocene.

Palæosyops minor, sp. nov.

This species is indicated by a molar tooth, from the right lower jaw, and probably by some other less characteristic remains. The tooth, which is apparently from near the middle of the series, is of the *Palæotherium* type, and nearly resembles in its main characters the corresponding molar of *Palæosyops*. The crown is composed of two united, antero-posterior lobes, with crescent-shaped summits. The anterior lobe is the more elevated, and the posterior has a greater fore and aft extent. The animal thus represented was apparently about as large as the South American Tapir, and less than one half the size of *Palæosyops paludosus* Leidy,* from the same deposits.

Measurements.

Antero-posterior diameter of lower molar,	10	lines.
Transverse diameter of front lobe, at summit,	5·	"
Transverse diameter of posterior lobe, at summit,	5·6	"

The only known specimens of this species were found by the writer at Grizzly Buttes, near Fort Bridger, Wyoming, in the same deposits as the preceding species.

Lophiodon Bairdianus, sp. nov.

The remains on which this species is based consist of portions of several skeletons, with numerous teeth which show considerable variation in size and other characters of minor importance. The various specimens indicate an animal somewhat smaller than the modern Tapir of South America, but much larger than the *Lophiodon modestus*,† founded by Dr. Leidy on a tooth from the same Tertiary beds that afforded the fossils under consideration. From the latter species, so far as it is now known, the present specimens may be readily distinguished, moreover, by the enamel of the teeth, which, instead of being coarsely wrinkled, is nearly smooth, or marked by very delicate, irregular striæ.

Measurements.

Length of portion of upper jaw, enclosing the three posrior molars,	25·	lines.
Antero-posterior diameter of last upper molar,	9·	"
Transverse diameter of same,	10·25	"
Length of fragment of lower jaw with three posterior molars,	25·	"

* Proceedings Philadelphia Academy of Natural Sciences, 1870, p. 113.

† Proceedings Philadelphia Academy of Natural Sciences, 1870, p. 109.

The specimens now representing this species, which is one of the most common fossil mammals in the earlier Tertiary of Western Wyoming, were found by G. B. Grinnell, J. W. Griswold, C. W. Betts, A. H. Ewing, J. M. Russell, and the writer, at various localities near Fort Bridger, and on the White River, in Eastern Utah. The species is named in honor of Professor S. F. Baird, of the Smithsonian Institution.

Lophiodon affinis, sp. nov.

A second and somewhat smaller species of the same genus, closely allied to the preceding, is indicated by various fragmentary remains, including several molar teeth in an excellent state of preservation. A comparison of the last upper molar with that of *L. Bairdianus*, shows, aside from the smaller size, a marked difference, especially in the contour of the crown, which has a deep notch in the outer posterior margin of the base, between the external tubercles in which the transverse ridges terminate. In the species just described, the margin is here nearly straight. The present specimen, moreover, has the small anterior external tubercle more prominent, and less closely connected with the adjoining ridge. This tooth is larger than the corresponding one of *Lophiodon modestus*, and has quite different proportions. The enamel, also, is similar to that in the preceding species.

Measurements.

Antero-posterior diameter of last upper molar.....	7·1	lines.
Transverse diameter of same,.....	8·3	"
Antero-posterior diameter of penultimate upper molar,	8·	"
Transverse diameter of same,.....	8·	"

The principal specimens on which this species is established were found by H. D. Ziegler, in the Mauvaises Terres beds, near Marsh's Fork, Wyoming.

Lophiodon nanus, sp. nov.

A small, well marked species, apparently of the genus *Lophiodon*, is represented by a number of fossils collected by the Yale party at various localities. The most characteristic of these specimens is a right upper jaw containing a series of four premolars, and three molars, and part of the corresponding left jaw with several teeth of the same animal. The molars differ especially from those of the two preceding species, in having a much shallower valley between the two transverse ridges, and in having a strong basal ridge, or shelf, at the external posterior corner of the crown. The enamel of the whole series is very smooth. The species was probably about two thirds the size of *L. modestus*.

Measurements.

Length of portion of upper jaw, containing seven posterior teeth,	26·	lines.
Length of same, with three last molars,	13·7	"
Antero-posterior diameter of last upper molar,	5·	"
Transverse diameter of same,	5·25	"

The remains now known to represent this species were discovered by C. W. Betts, H. B. Sargent, and the writer, in the Tertiary strata at Grizzly Buttes, near Fort Bridger.

Lophiodon pumilus, sp. nov.

A still more diminutive species, of the same, or a nearly related, genus, is indicated by several specimens, including a fragment of a left upper jaw, containing three premolars and the two succeeding molar teeth. The species may easily be distinguished from the small one above described, by the presence, on the outside of the superior teeth, of a strong, continuous, but irregular basal ridge, which, at the external angle of the crown, replaces the elevated tubercle present in all the molars of the species already noticed. The present specimen may also be distinguished from *L. nanus*, by the form of the last two upper premolars, which in the latter have their greatest transverse diameter behind the center, while the reverse is true of these premolars in the species under consideration.

Measurements.

Length of portion of upper jaw, with three premolars, and next two molars,	14·	lines.
Antero-posterior diameter of penultimate upper molar,	3·25	"
Transverse diameter of same,	4·	"

The only specimens at present known to represent this species were found by C. T. Ballard, in the Tertiary beds near Marsh's Fork, Western Wyoming.

Anchitherium gracilis, sp. nov.

The Green River Tertiary basin of Wyoming apparently contains very few extinct solipedal mammals, one or two fragments only being all our party secured during several weeks of explorations. In the Uintah or southern basin, however, especially near the White River of Eastern Utah,* remains of this group are more abundant, and some characteristic specimens were obtained. Among these, were three lower jaws, with many of the teeth in good preservation. They represent an animal less than one half the size of *Anchitherium Bairdi* Leidy, and apparently belonging to the same genus. There are seven premolar and molar teeth, with essentially the same constitution as in that

* This Journal, vol. i, p. 196, March, 1871.

species. The first premolar has but one fang, and between this and the symphysis there are no teeth. On the inner face of each ramus there is a shallow, sickle-shaped impression, with the point directed forward, and terminating under the first premolar.

Measurements.

Length of portion of lower jaw, with six posterior teeth,	23·58	lines.
Length of same with three posterior teeth,	12·5	"
Antero-posterior diameter of last lower molar,	5·	"
Transverse diameter of same,	2·	"

The above specimens were discovered by C. T. Ballard and the writer, on the north side of the White River, in Eastern Utah. The geological horizon is upper Eocene, or lower Miocene.

Lophiotherium Ballardi, sp. nov.

A small Pachyderm, apparently nearly related to the genus *Lophiotherium*, is indicated by a fragment of a right lower jaw, with the last two molars, and a few less important remains. The species thus represented appears to have been about two thirds the size of *Lophiotherium sylvaticum*, recently described by Dr. Leidy from the same Tertiary basin in which these fossils were found,* and the teeth, so far as known, have nearly the same composition. Those preserved in the present specimen are somewhat worn, showing that the individual was fully adult. The enamel, especially on the sides of the crown, is much wrinkled, and thus the external basal ridge is rendered strongly serrated.

Measurements.

Antero-posterior diameter of last lower molar,	4·4	lines.
Transverse diameter of same,	2·1	"
Antero-posterior diameter of penultimate lower molar,	3·2	"
Transverse diameter of same,	2·25	"

The species is named for the discoverer, Mr. C. T. Ballard, of the Yale party, who obtained the specimens here described at Grizzly Buttes, Western Wyoming.

Elotherium lentus, sp. nov.

The presence of numerous Suilline Pachyderms in the Green River Tertiary basin was clearly established during the investigations of our party by the discovery of several extinct species, all different from any hitherto described. One of these, which evidently belonged to the genus *Elotherium*, is represented by a single fragment of a left lower jaw, with the last molar in fine preservation. This specimen indicates a species about one half the size of *Elotherium Mortoni* Leidy, which is comparatively abundant in the lower Tertiary deposits east of the Rocky Moun-

* Proceedings Philadelphia Academy of Natural Sciences, 1870, 126.

tains. The upper surface of this last lower molar is composed of two transverse pairs of conical lobes, with a single posterior one on the median line. The anterior inner cone is larger than its fellow, and has its summit bifid. In the next pair, which are much less elevated, the external lobe is the larger. The posterior cone is low, and shows a tendency to subdivide. There is a basal ridge in front, and indications of its continuation on the external border. The enamel is finely corrugated. There is a prominent rugose tubercle on the inner superior margin of the lower jaw, a short distance behind and above the last molar.

Measurements.

Antero-posterior diameter of last lower molar,	9· lines.
Greatest transverse diameter of same,	5· "
Transverse diameter between first and second pair of cones,	4·4 "

The specimen on which this species is established was found by the writer, in October last, in the Tertiary beds, on Henry's Fork, Wyoming.

Platygonus Ziegleri, sp. nov.

Remains of another Suilline animal, fully as large as the modern *Sus scrofa*, were obtained in the same Tertiary beds with the last species. The most characteristic specimens discovered are a number of upper premolar and molar teeth, which agree so nearly in general composition with those of *Platygonus*, that they may very properly be referred to that genus. One prominent character in these teeth, especially the anterior ones, is the remarkably strong basal ridge, which, on the inner border at least of the first and second premolars, exceeds in breadth that in *Platygonus compressus* LeConte, although on the posterior margin it is less developed than in that species. The crowns of all the upper premolars are composed of a single transverse pair of cones, closely united. The second premolar in this specimen has a greater fore and aft diameter than the third. The enamel of all the teeth is rugose, as in the modern Peccaries.

Measurements.

Length of fragment of upper jaw, containing the three premolars,	18·5 lines.
Antero-posterior diameter of first upper premolar,	6· "
Transverse diameter of same,	6· "
Antero-posterior diameter of second upper premolar,	6·5 "
Transverse diameter of same,	7·3 "
Antero-posterior diameter of third upper premolar,	6·2 "

The species is named for H. D. Ziegler, of Yale College, who discovered the specimens on which the present description is based. The locality was at Grizzly Buttes, near the base of the Uintah Mountains.

Platygonus striatus, sp. nov.

A third Suilline species, nearly related apparently to the last, and quite equaling it in size, is indicated by portions of two lower jaws, with a few of the anterior teeth, collected by our party in the Pliocene strata of Northern Nebraska. In one of the specimens, the second left premolar is well preserved, and characteristic. It has the same general composition as the corresponding tooth in *Platygonus compressus*, but, in addition to its much larger size, it is proportionally broader, and has the basal ridge in front less developed. The posterior basal ridge, moreover, is expanded into two rudimentary tubercles. The enamel is marked by delicate irregular striæ, mostly parallel with the base of the crown, and to this ornamentation the specific name refers.

Measurements.

Length of portion of left lower jaw containing first four teeth,	25·	lines.
Length of same, with first three teeth,	17·	"
Antero-posterior diameter of second lower premolar,	6·2	"
Transverse diameter of same,	5·8	"

The above specimens were found by the writer, in July last, in the Pliocene sands, near the head-waters of the Loup Fork River, Nebraska.

Platygonus? Condoni, sp. nov.

The present species is founded on a portion of a right upper jaw containing the three posterior molars. The specimens evidently belonged to a true Suilline mammal, at least equal in size with the last two described. The exact generic relations of the species cannot at present be ascertained, but it differs essentially from any known recent or extinct American species of this group in several particulars. One of the most marked of these is the unusual elongated fore and aft proportions of the last upper molar, which has to the diameter of the penultimate tooth the ratio of three to two. The crown of the posterior molar is composed of two transverse pairs of principal cones, the front pair being the larger, and a posterior lobe, which is partially divided into three tubercles. The enamel is smooth, and there is no basal ridge on the sides of the teeth preserved.

Measurements.

Length of jaw enclosing last three upper molars,	27·	lines.
Antero-posterior extent of last molar,	12·	"
Transverse diameter of same, through anterior lobes,	7·	"
Antero-posterior extent of penultimate molar,	8·	"

This species is named for Rev. Thomas Condon, who discovered the specimen described, in the Pliocene beds of Oregon.

Dicotyles Hesperius, sp. nov.

A new and interesting small Suilline mammal is well represented by a portion of a right upper jaw, with the last premolar, and the succeeding three molars, all in excellent preservation. The teeth indicate an individual fully adult. They have nearly the composition of those of the modern Peccaries, and evidently belonged to the same, or a closely related, genus. The species is well marked, and was apparently not more than one half the bulk of *Dicotyles torquatus*. The crowns of the molars have a more rhombic outline than in that species, and a more distinct valley between the anterior and posterior pair of cones. The basal ridge is also more strongly developed, especially on the outer margin, where it is continuous. In other respects the composition of these teeth is very similar in the two species. The last upper premolar in the present specimen, however, differs widely from the corresponding tooth in any of the known Peccaries, living or fossil, resembling most nearly in its composition the second premolar of *D. torquatus*. The latter has, however, the single posterior cone distinct, while in the species under consideration it is connate with the anterior outer tubercle. The upper dental series is here somewhat curved outwardly, and not on a line, as in the living Peccaries.

Measurements.

Length of part of upper jaw with four posterior teeth,	19·	lines.
Length of same, with three molars,	15·2	"
Antero-posterior diameter of last upper molar,	5·6	"
Transverse extent of same,	4·	"
Antero-posterior diameter of penultimate upper molar,	5·4	"

This specimen, for which the writer is likewise indebted to Rev. Mr. Condon, is from the same locality and geological horizon as the species last described.

Hypsodus gracilis, sp. nov.

This species was about the same size as *Hypsodus paulus*, a small mammal described by Dr. Leidy from the lower Tertiary basin in Wyoming, and supposed by him to indicate an animal probably allied to the suilline family.* It may readily be distinguished from that species, especially by the first true molar of the lower jaw, which is proportionally narrower in front, and broader at its posterior margin. There is also on this tooth a strong external basal ridge, and, at the anterior inner angle, a prominent projection, which is wanting in *H. paulus*. The lower jaw is, moreover, deeper and more compressed in the region of the premolars.

* Proceedings Philadelphia Acad. Nat. Science, 1870, p. 109.

Measurements.

Length of part of lower jaw containing first molar and last two premolars,	5·1	lines.
Antero-posterior diameter of first lower molar,	2·	"
Transverse diameter through posterior lobe,	1·6	"
Antero-posterior diameter of last lower premolar,	1·6	"

The specimens representing this species at present were found by the writer, at Grizzly Buttes, Wyoming.

Limnotherium tyrannus, gen. et sp. nov.

A somewhat larger pachyderm, but distantly allied apparently to the two small species last described, is represented by the anterior portions of two united lower jaws, with several teeth, and a few other fragmentary remains. These specimens appear to indicate a genus quite distinct from any hitherto known, but additional remains will probably be required to determine its exact affinities. The teeth of the lower jaws are twenty in number, and form an uninterrupted series, which may be divided as follows:—Incisors 2–2, canines 1–1, premolars 4–4, molars 3–3. The incisors are small, and crowded together. The canines are large, nearly round at the base, and evidently formed most efficient weapons. The first and second premolars had but a single fang. The two anterior molars are in excellent preservation, and have their crowns composed of four principal cones. The first is at the anterior outer angle; the second just behind this, on the inner margin; the third at the outer posterior angle; and the fourth and smallest at the inner posterior corner, separated from the others by a deep pit. Each molar has a rudimentary double tubercle on the anterior margin, and a moderate basal ridge, except on the inner side.

Measurements.

Length of dental series of lower jaw,	18·	lines.
Antero-posterior extent of three molars,	7·5	"
Transverse extent of four incisors,	3·	"
Length of symphysis,	8·5	"
Depth of lower jaw below last molar,	5·15	"
Depth below last premolar,	6·	"
Antero-posterior extent of first lower molar,	2·5	"
Transverse diameter of same,	2·	"

The specimens here described were found by the writer near Dry Creek, Western Wyoming, in deposits which are probably of Upper Eocene age.

Limnotherium elegans, sp. nov.

A diminutive mammal is represented in our collections by portions of two lower jaws, with several teeth, which have so

nearly the composition of those in the preceding species that they undoubtedly belong to the same, or a nearly related, genus. One of these specimens contains the last premolar, and the two succeeding molars. In the latter, the two anterior cones form a transverse pair, and are not oblique as in the larger species. The posterior pair of tubercles, also, are nearly on a transverse line.

Measurements.

Length of fragment of lower jaw, enclosing last premolar and three molars,	7·5	lines.
Antero-posterior diameter of second lower molar,	2·	"
Transverse diameter of same,	1·6	"

The only two specimens of this species now known were found by the writer at Grizzly Buttes, near the base of the Uintah Mountains, in Wyoming.

Yale College, New Haven, June 5th, 1871.

ART. IX.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School.* No. 16.—*On the Atomic Weights of Cobalt and Nickel;* by RICHARD H. LEE.

THE atomic weights of cobalt and nickel have long been subjects of controversy, but though much time and labor have been spent upon them, the results arrived at are not as satisfactory as could be desired.

Under these circumstances Prof. Gibbs suggested to me a new investigation of the subject. Before giving an account of my own methods and results, I will state briefly those of other chemists. Rothhoff,* in 1826, first endeavored to ascertain the atomic weights of cobalt and nickel. He determined the amount of chlorine in the respective chlorides, by means of silver, and from a single analysis of each chloride, obtained for cobalt the equivalent 29·55, and for nickel the equivalent 29·60. As the methods of separating the two metals were at that time imperfect, and as but a single analysis was made in each case, Rothhoff's results can hardly be considered as deserving of confidence.

Erdmann† and Marchand, in 1852, determined the atomic weight of nickel by reducing nickelous oxide in hydrogen. Their results varied between 29·1 and 29·3, and they regarded the lower number as more probably correct. It seems at least possible that the nickel they employed contained traces of cobalt. The subject was again taken up by Schneider‡ in 1857.

* Poggendorff's Annalen, vol. viii, p. 184–5.
† Annalen der Pharmacie, vol. lxxxii, p. 76.
‡ Poggendorff's Annalen, ci, p. 387.

Pure metallic cobalt was prepared by igniting chloride of purpureocobalt in hydrogen. The metal was then dissolved in chlorhydric acid and precipitated by sodic carbonate. The carbonate was washed, and then digested with oxalic acid, the resulting oxalate again washed, burned in a current of oxygen and the oxide reduced by hydrogen. In other portions of the oxalate the carbon was determined by combustion with cupric oxide.

The following table gives a summary of the results obtained:

	Oxalate taken.	Cobalt found.	Carbon found.	Equivalent Co.
1.	1·6355 2·3045	32·552 pr. ct.	13·024 p. c.	29·993
2.	1·1070 1·9010	32·619 "	13·041 "	30·015
3.	2·3090 4·0580	32·528 "	13·005 "	30·014
4.	3·0070 5·3500	32·523 "	13·014 "	29·989
			Mean,	30·003

Determinations of the atomic weights of cobalt and nickel were also made in 1857 by Marignac.* Cobaltous sulphate was purified by repeated crystallization and a weighed quantity of the salt heated so as to expel the acid. The resulting oxide was then heated with a known weight of silicate of lead so as to expel the excess of oxygen over and above that required to form cobaltous oxide CoO. The results obtained varied between 29·32 and 29·38.

Crystallized cobaltous chloride dried at 100° was found to retain one atom of water. Three determinations of the chlorine in this salt by means of silver, gave for the atomic weight of cobalt 29·42 to 29·51. Anhydrous cobaltous chloride was obtained by heating the crystallized salt with sal-ammoniac, in a current of dry chlorine or dry chlorhydric acid gas. The salt almost always however left a slight residue insoluble in water. Five analyses of the anhydrous salt gave results varying from 29·36 to 29·42.

In 1859 Dumas† turned his attention to the subject. Perfectly pure metallic cobalt was dissolved in nitro-muriatic acid, the solution evaporated to dryness with frequent additions of chlorhydric acid, and the cobaltous chloride submitted to a red heat. In a second preparation from a different sample of metal the chloride was dried in vacuo. In this manner the following results were obtained:

* Bibliothique Universelle de Geneve, Nouvelle series, vol. i, p. 373.

† Ann. de Chimie et de Physique, 3d series, vol. lv, p. 148.

	$CoCl_2$.	Silver.	Equivalent.
1	2·352	3·9035	29·57
2	4·210	6·990	29·54
3	3·592	5·960	29·59
4	2·492	4·1405	29·50
5	4·2295	7·0255	29·51

The mean of these five determinations is 29·54. In all cases the chloride was dissolved in boiling water and the solution allowed to cool before precipitating with $AgNO_3$. The argentic chloride was reduced in hydrogen. The method employed for the preparation of pure cobalt is not stated.

Russell* determined the atomic weights of cobalt and nickel in 1863. Pure metallic cobalt was prepared by igniting chloride of purpureocobalt in hydrogen. The metal was dissolved in nitric acid and the solution evaporated and strongly heated. The black oxide obtained was ignited in a current of carbonic di-oxide, by which it was converted into light brown cobaltous oxide CoO, which was then reduced by pure hydrogen. Omitting two trial experiments, the results obtained were as follows:

	CoO.	Cobalt.		Cobalt pr. ct.
First sample, 1	2·1211	1·6670		78·591
2	2·0241	1·5907		78·588
3	2·1226	1·6673		78·550
4	1·9947	1·5678		78·598
5	3·0628	2·4078		78·614
			Mean,	78·588
First specimen twice purified—				
1	2·1167	1·6638		78·603
2	1·7717	1·3924		78·591
3	1·7852	1·4030		78·591
			Mean,	78·595
First specimen three times purified—				
1	1·6878	1·3264		78·588
2	2·2076	1·7350		78·592
			Mean,	78·590
Second specimen—				
1	2·6851	2·1104		78·597
2	2·1461	1·6868		78·598
			Mean,	78·597
Third specimen—				
1	3·4038	2·6752		78·595
2	2·2778	1·7901		78·589
3	2·1837	1·7163		78·596
			Mean,	78·593

* Annalen der Pharmacie, vol. cxxvi, pp. 322–336.

The mean of all the results is 78·5926, from which we find for the equivalent of cobalt on the old system 29·37.

In 1866 the subject was taken up by Sommaruga,* who determined the amount of metallic cobalt in chloride of purpureocobalt by reduction in a bulb tube with hydrogen. His results were as follows:

	Salt taken.	Cobalt found.	Equivalent.
1.	0·6656	0·1588	30·002
2.	1·0918	·2600	29·929
3.	0·9058	·2160	29·982
4.	1·5895	·3785	29·926
5.	2·9167	·6957	29·992
6.	1·8390	·4378	29·916
7.	2·5010	·5968	30·009
		Mean,	29·965

Winkler,† in 1867, determined the atomic weight of cobalt by heating a known weight of the metal with a perfectly neutral solution of double chloride of gold and sodium. The cobalt was obtained by the reduction of chloride of purpureocobalt.

	Salt taken.	Gold found.	Equivalent of Co(Au=196.)
1.	0·5890	1·3045	29·497
2.	0·3147	0·6981	29·451
3.	0·5829	1·2913	29·492
4.	0·5111	1·1312	29·518
5.	0·5821	1·2848	29·522
		Mean,	29·496

Finally, in 1869, Weselsky‡ made a new determination of the atomic weight of cobalt by finding the quantity of metallic cobalt in weighed quantities of cobalticyanide of aniline-ammonium and of ammonium. The results were as follows:

	Cobalt salt.	Cobalt found.	Equivalent.
1.	0·8529 gr.	0·1010	29·44
2.	0·6112 "	0·0723	29·38
3.	0·7140 "	0·0850	29·59
4.	0·9420 "	0·1120	29·54
1.	0·7575 "	0·1160	29·46
2.	0·5143 "	0·1130	29·55
		Mean,	29·48

The first four analyses were made with the anilin, the last two with the ammonium salt. These are the only determinations of the atomic weight of cobalt which I have been able to find, and I will therefore pass to my own analyses.

* Sitzungsberichte der Wiener Akad., vol. liv, p. 50.
† Zeitschrift für Anal. Chemie, 1867, p. 18.
‡ Berichte der Deutschen Chem. Gesellschaft, 1870.

Commercial cobaltic oxide was treated in a large porcelain crucible with enough strong sulphuric acid to make it into a stiff paste. The crucible was then placed in a muffle furnace and heated for some time, at first gently and afterwards to low redness. The sulphate obtained was dissolved, filtered and submitted for some time to a current of sulphydric acid gas, by which copper, arsenic, &c., were removed. The filtrate was treated with chlorine water to peroxydize the iron present and then allowed to stand for 48 hours in contact with baric carbonate, the whole being frequently and thoroughly stirred. In this manner iron and manganese were almost wholly removed. The filtrate was then treated with a large excess of baric carbonate, and cyanhydric acid gas passed into the liquid until the whole of the cobalt was converted into cobalti-cyanide of barium, $Co_2Cy_{12}Ba_3$. The solution of this salt was then boiled with mercuric oxide to separate the nickel present, as $NiCy_4Ba$, as well as traces of iron and manganese. The mercury was then removed from the filtrate by sulphydric acid gas, and the solution of cobalti-cyanide barium regarded as chemically pure. The methods which I adopted to determine the atomic weight of cobalt do not differ in principle from those of Weselsky and Sommaruga. I first formed cobalti-cyanides of alkaloids having high atomic weights and forming highly crystalline and perfectly definite double cyanides. I then determined the water of crystallization in these salts directly, and afterwards the percentage of cobalt in each. This last was effected by first carefully heating the salt in a platinum crucible by means of a ring-burner, and afterwards burning off the carbon, first in air and then in oxygen. Finally the cobalt was reduced to metal by a current of pure hydrogen, and weighed. In this manner but two weighings were necessary. In another series of experiments, I determined the amount of metallic cobalt in weighed quantities of chloride of purpureocobalt by igniting the salt in a current of pure hydrogen gas. To effect the reduction without loss, I employed an arrangement due to Dr. Gibbs, and consisting of a small thin disk of porous earthenware. The chloride of purpureocobalt was placed in a porcelain crucible and the disk of earthenware supported above it by the walls of the crucible. The hydrogen was introduced by a tube passing into the bored cover and the crucible was then carefully heated from above. In this manner the gas diffused through the porous septum, which in turn served to prevent the escape of any particles of solid substance. The reduction was absolutely complete, and the metal did not oxidize after slowly cooling in an atmosphere of hydrogen. In the analyses made in this manner, also, but two weighings were necessary.

In my first series of experiments I employed only the cobalti-cyanides of brucine and strychnine, the corresponding salts of morphine, narcotine, chinine and cinchonine having been found difficult to prepare in a state of purity by recrystallization. The brucine and strychnine salts were prepared by decomposing the sulphates of these bases with cobalti-cyanide of barium, and repeatedly recrystallizing the salts formed. The brucine salt crystallized in beautiful white, barb-shaped crystals with a high luster. It was but slightly soluble in cold water, and crystallized with remarkable facility. The strychnine salt was in beautiful, nearly colorless needles, and like the brucine salt crystallized almost completely from its solution on cooling. Six analyses were made with each of these salts.

Of the strychnine salt—

0·7084 gr. dried at 115°C. lost 0·0392 gr. of water = 5·53 p. c. The formula, $Co_2Cy_{12}(C_{21}H_{22}N_2O_2)_6H_6+8OH_2$, requires 5·57 p. c. water of crystallization.

The following are the results of my determinations of the amount of cobalt in this salt:

No.	Salt taken.	Cobalt.	Cobalt, p c.	At. weight.
1.	0·4255 gr.	0·0195 gr.	4·583	59·22
2.	0·4025 "	0·0185 "	4·596	59·36
3.	0·3733 "	0·0170 "	4·554	58·83
4.	0·4535 "	0·0207 "	4·564	58·96
5.	0·2753 "	0·0126 "	4·577	59·14
6.	0·1429 "	0·0065 "	4·549	58·76
		Mean,	4·5705	59·05

The probable error of the mean is ±0·012, and the atomic weight of cobalt 59·05, with a probable error of ±·156. In the case of the brucine salt, three determinations of the water of crystallization were made.

0·4097 gr. gave 0·0465 gr. water at 117° C. = 11·35 p. c.
0·3951 gr. " 0·0453 gr. " 119° C. = 11·46 p. c.
0·6653 gr. " 0·0752 gr. " 128° C. = 11·30 p. c.

The mean of these three determinations is 11·37 p. c.

The formula $Co_2Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6+20OH_2$ requires 11·39 p. c. water of crystallization.

The results of my determinations of the amount of metal in this salt are as follows:

	Salt taken.	Cobalt.	Cobalt, p. c.	At. weight.
1.	0·4097 gr.	0·0154 gr.	3·759	59·41
2.	0·3951 "	0·0147 "	3·720	58·76
3.	0·5456 "	0·0204 "	3·739	59·08
4.	0·4402 "	0·0165 "	3·748	59·22
5.	0·4644 "	0·0174 "	3·747	59·21
6.	0·4027 "	0·0151 "	3·749	59·24
		Mean,	3·7437	59·15

The probable error of the mean is here ±0·0088, and the atomic weight of cobalt 59·15, with a probable error of ±·146.

The method of analyzing the chloride of purpureocobalt has already been described. The results of my analyses are as follows:

No.	Salt taken.	Cobalt.	Cobalt, p. c.	At. weight.
1.	0·9472 gr.	0·2233 gr.	23·575	59·07
2.	0·8903 "	0·2100 "	23·587	59·11
3.	0·6084 "	0·1435 "	23·586	59·11
4.	0·6561 "	0·1547 "	23·579	59·08
5.	0·6988 "	0·1647 "	23·569	59·05
6.	0·7010 "	0·1653 "	23·581	59·09
		Mean,	23·5795	59·09

The probable error of the mean is here ±0·004, and the calculated atomic weight 59·09, with a probable error of ±·0146.

The mean of my eighteen determinations of the atomic weight of cobalt is 59·10. For the sake of comparison I give here the results obtained by other observers, in tabular form, reduced to the modern scale of atomic weights:

Rothhoff,	59·10	Dumas,	59·08	Winkler,	58·99
Schneider,	60·00	Russell,	58·74	Weselsky,	58·96
Marignac,	58·84 to 59·02 58·72 to 58·84	Sommaruga,	59·93	Lee,	59·10

Nickel.—The atomic weight of nickel was also first determined by Rothhoff* in 1826, by determining the amount of chlorine in a weighed quantity of nickelous chloride. A single experiment gave for the equivalent 29·60, a number which is probably too high, in consequence of the imperfection of the processes known at that time for the separation of nickel from cobalt. Erdmann and Marchand took up the subject in 1852.† Nickelous oxide prepared by various processes was reduced in a current of hydrogen and the metal weighed. No data are given, but the authors state that their results varied between 29·1 and 29·3, and that they consider the lower number more probably correct.

Schneider,‡ in 1857, also determined the atomic weight of nickel. Pure nickelous oxalate was burnt with cupric oxide to determine the oxalic acid, while the amount of metallic nickel was obtained by reducing the oxide with pure hydrogen. In this manner Schneider obtained as the mean of four analyses the number 29·02.

Marignac,§ in 1857, determined the atomic weight of nickel by methods precisely similar to those employed by him in the

* Pogg. Ann., vol. viii, p. 184.
† Ann. der Pharmacie, lxxxii p. 76.
‡ Pogg. Ann., ci, p. 387.
§ Bibliothique Universelle de Geneve, Nouvelle Series, vol. i, p. 373.

case of cobalt already cited. His analyses of the sulphate of nickel gave results varying from 29·2 to 29·5, while those of the chloride gave results varying between 29·4 and 29·64. Marignac does not give his method of obtaining pure salts of nickel.

The subject was next investigated by Dumas,* who determined the quantity of chlorine in nickelous chloride, and obtained for the equivalent of nickel as a mean of five analyses the number 29·514. The author does not give the process by which the nickel was obtained free from cobalt.

Russell† took up the subject of the atomic weight of nickel, together with that of cobalt, in 1863. Pure nickelous oxide was first ignited in a current of carbonic di-oxide, and afterward in pure hydrogen. His results were as follows:

						Metal.
1st specimen,	mean of 3	determinations	100	parts	of oxide, gave	78·596 Ni.
2.	"	"	"	"	"	78·584 "
3.	"	"	"	"	"	78·598 "
4.‡	"	"	"	"	"	78·592 "

The mean of all the determinations gave for the quantity of nickel in 100 parts of the oxide 78·5925, and for the atomic weight of nickel 58·74.

In 1866, Sommaruga§ determined the atomic weight of nickel by ascertaining the quantity of sulphuric acid in pure crystallized double sulphate of nickel and potassium. The mean of six analyses gave for the equivalent of nickel the number 29·013, with a probable error of ±0·079.

Winkler,‖ in 1867, employed the method of reduction already described. The mean of four analyses gave for the equivalent 29·527, with a probable error of ±0·056.

With these preliminary statements I pass to an account of my own methods and results. Metallic nickel of commerce was dissolved in nitro-sulphuric acid, and the nitric acid expelled by heat. The sulphate was then dissolved in water and the traces of copper and arsenic removed by a long continued current of sulphydric acid gas. The iron in the filtrate was then oxydized by means of bromine, and precipitated by agitation with Ba Co_3. The cobalt was removed by potassic nitrite and the nickelous sulphate then converted into nickel-cyanide of potassium, which was recrystallized. This salt contained only a trace of cobalt, after four crystallizations. To determine the atomic weight of nickel I adopted the method already employed to determine that of cobalt. I first formed the double cyanides of nickel with brucine and strychnine, and then determined, first

* Ann. de Chimie et de Physique, 3d series, vol. lv, p. 148.
† Ann. der Pharmacie, vol. cxxvi, p. 322 to 336.
‡ Second purification.
§ Sitzungsberichte der Weinen Akad., vol. liv, p. 50.
‖ Zeitschrift für Analyt. Chemie, 1867, p. 18.

the quantity of water in each of these salts, and afterward the percentage of metallic nickel. This last determination was effected by first carefully heating the salt in a platinum crucible, employing the ring-burner of Dr. Gibbs so as to apply the heat at the rim of the crucible first, and afterward in successive zones until the bottom of the crucible was reached. The remaining carbon was then burned off in a current of pure oxygen, and the oxide of nickel finally reduced by igniting it in carefully purified hydrogen. The double cyanides of nickel, brucine and strychnine were prepared by double decomposition, the salts being but slightly soluble in cold water. They were then repeatedly recrystallized, and when tested by the spectroscope were found to be absolutely free from potassium. All of these salts crystallized in very pale yellow needles.

My analyses of the brucine salt led to the following results:

0·4496 gr. dried at 120° C. lost 0·0258 gr. ΘH_2 = 5·738 p. c. water.

The formula $Ni_3Cy_{12}(C_{23}H_{26}N_2O_4)_6H_6+10\Theta H_2$, requires 5·929 p. c.

No.	Salt taken.	Nickel.	Nickel, p. c.	At. weight.
1.	0·3966	0·0227	5·724	57·92
2.	0·5638	0·0323	5·729	57·98
3.	0·4000	0·0230	5·750	58·20
4.	0·3131	0·01795	5·733	58·02
5.	0·4412	0·0252	5·712	57·79
6.	0·4346	0·0249	5·729	57·98
		Mean,	5·7295	57·98

The probable error of the mean percentage of nickel is ±0·008, and the atomic weight of nickel 57·98, with a probable error of ±0·089.

Six analyses of the strychnine salt were then made:

0·3399 gr. dried at 112° C. lost 0·0178 gr. water = 5·24 p. c.

The formula $Ni_3Cy_{12}(C_{21}H_{22}N_2O_2)_6H_6+8\Theta H_2$, requires 5·45 p. c.

No.	Salt taken.	Nickel.	Nickel, p. c.	At. weight.
1.	0·5358	0·0354	6·607	58·15
2.	0·5489	0·0363	6·613	58·21
3.	0·3551	0·0234	6·589	57·98
4.	0·4495	0·0297	6·607	58·15
5.	0·2530	0·0166	6·561	57·72
6.	0·1956	0·0129	6·595	58·04
		Mean,	6·595	58·04

The probable error of the mean percentage of nickel is ±0·013, and the atomic weight 58·038, with a probable error of ±0·119.

The mean of all my determinations of the atomic weight of

nickel is 58·01. The following table gives all the determinations made:

Rothhoff,	59·20	Dumas,	59·028
Erdmann and Marchand,	58·20 to 58·60	Russell,	58·74
		Sommaruga,	58·026
Schneider,	58·04	Winkler,	59·054
Marignac,	58·40 to 59	Lee,	58·01

In conclusion, my thanks are due to Dr. Gibbs for the selection of the subject of my work, and for his advice during the course of my investigation.

Cambridge, May, 1871.

ART. X.—*Note on the Spectrum of the Corona*; by Prof. C. A. YOUNG.

IN an article upon the Solar Corona, which appeared in the May number of this Journal, I wrote, "very perplexing also is the fact that the faint continuous spectrum, which must be in part produced by this polarized component of the corona's light, shows no discoverable traces of the dark lines of the ordinary sunlight-spectrum. Probably they exist, but are in some way masked so that they are not easily detected."

On further reflection, however, I believe the matter is readily explained, and that on the other hand it would have been remarkable if we had been able to bring out the Fraunhofer lines.

The truth is that the reflected photospheric sunlight forms only one small fraction of the total coronal radiance, the other constituents of which so far preponderate that it becomes very difficult to detect in the general spectrum the characteristics of this reflected light.

The spectrum of the corona is, in all probability, composed of at least *four* superposed elements.

1st. A continuous spectrum, without lines either bright or dark, due to incandescent dust—that is, to particles of solid or liquid meteoric matter near the sun. For although I am not able to admit with Mr. Proctor that the whole explanation of the corona is involved in the presence of such meteoric particles, yet it cannot be doubted that they are very numerous; and any that may come within 250,000 miles of the solar surface must become incandescent and give such a spectrum as described.

2nd. A true gaseous spectrum of the second order, consisting, like all such spectra, of a more or less bright continuous background with well marked maxima or bright lines. In this case one bright line (1474) certainly exists, and perhaps several. So

far as the spectroscopic evidence goes this gas may be simply the vapor of the meteoric dust above alluded to, liberated by the heat of the sun, as when powdered sodium is dropped into an alcohol flame; or it may be disengaged for the instant from the same particles by electric discharges between them, as when the bright lines of metallic vapor appear in the spectrum of the spark produced by an induction coil. But in my previous article I have stated reasons for believing that the gas is of a more permanent character—a solar atmosphere through and in which the meteoric particles move as foreign bodies.

3rd. A true sunlight-spectrum (with its dark lines) formed by photospheric light reflected from the solar atmosphere and meteoric dust. To this reflected sunlight undoubtedly is due most of the polarization, and were it possible to separate the polarized component of the coronal light from the rest, we might perhaps hope to find in it traces of the Fraunhofer lines. It is by no means impossible, however, that the spectroscopic character of reflected light may undergo some change, such as a partial obliteration or degradation of its lines, when the reflecting particles are sufficiently minute—small, that is as compared with the dimensions of a wave of light, so that they do not merely reflect the undulation at their surfaces, but themselves enter into motion bodily. Experiments upon the spectrum of the light emitted by one of the so-called actinic clouds would, perhaps, clear up the subject.

4th. Another component spectrum is due to the light reflected from the particles of our own atmosphere. This is a mixture of the three already named, with the addition of the chromosphere spectrum; for while at the middle of an eclipse the air is wholly shielded from photospheric sunlight, it is of course exposed to illumination from the prominences and upper portions of the chromosphere. This light from the terrestrial atmosphere, like that reflected by particles near the sun, is evidently partially polarized in radial planes.

And if there is between us and the moon, at the moment of eclipse, any cloud of cosmical dust, the light reflected by this would come in as a *fifth* element. It would, however, only differ from that reflected by our own atmosphere by including a greater or less modicum of photospheric sunlight.

Furthermore, in instruments like those employed by Messrs. Abbay and Pye, the chromosphere spectrum overlies that of the corona, and increases the complication.

It would seem, therefore, that only a small percentage of the light which falls upon the slit of the spectroscope during a total eclipse contains the Fraunhofer lines at all, and it ought not to be considered strange that they are not readily observed.

In the same article I have stated that the photographs, taken by the American party in Spain, appear to differ essentially from those obtained by Mr. Brothers, in Sicily. This statement was based upon a comparison instituted by Mr. Lockyer, Professor Winlock and myself, between a copy of the American photograph and a drawing* of Mr. Brothers' photograph, which (drawing) he had himself sent to Mr. Lockyer.

There was a general and even striking agreement between the two in respect to the position of the 'gaps' and the distribution of the luminosity, yet there certainly were, as Mr. L. pointed out, very noticeable and important differences, and of a character to suggest that the extensive outside radiance might probably be of a less permanent character than the leucosphere, and of a different origin.

But I understand that when photographic copies of Mr. Brothers' and the American negatives are made to a common scale then these differences disappear and the agreement becomes nearly absolute in respect to all essential particulars. If this be so, it certainly bears very strongly in favor of those theories which assign a purely solar origin to the whole phenomenon.

Dartmouth College, May 10, 1871.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Note on Para-sulphobenzoic Acid;* by Ira Remsen, M.D., Ph.D., Assistant in the University laboratory, Tübingen, Germany. —In my former note. (volume i, page 462), I stated that when ordinary sulphobenzoate of potassium is fused with hydrate of potassium, a mixture of oxybenzoïc and para-oxybenzoïc acids is always formed, instead of pure oxybenzoïc acid, as was up to that time supposed. From this fact I concluded that two salts must be contained in ordinary sulphobenzoate of potassium.

In order to decide this point, I separated the free acid from the same potassium salt that had been made use of for the first experiment described in the note mentioned. This was accomplished by decomposing the salt with the necessary quantity of sulphuric acid, evaporating to dryness and extracting with alcohol. With the acid mixture obtained I prepared an acid barium salt, by neutralizing with carbonate of barium, dividing the solution into two equal parts, precipitating the barium from the one exactly with sulphuric acid and then mixing the two again. On evaporating this solution, it became filled with beautiful needles on cooling.

* I am not sure but we had a photographic copy of Mr. Brothers' drawing instead of the drawing itself; but we did not have a photographic copy of the original negative. No such copies had then been made.

These did not possess the least resemblance to the crystals of the known acid barium salt of sulphobenzoïc acid. They were filtered off and recrystallized. Their form was not changed by this process. The salt was now repeatedly recrystallized from water and each time it separated in needles which became longer and more beautiful, the finer they became. It was dried by being allowed to stand for some time over sulphuric acid, and then subjected to analysis. It contained water of crystallization, which was not driven off at a temperature lower than 250–260°. The salt has the formula $(C_{14}H_{10}S_2O_{10})\ Ba+3H_2O$. The analyses gave the following numbers:

Found,	H_2O	8·95 pr. ct. and	9·38 pr. ct.
	Ba	25·34 pr. ct. and	25·38 pr. ct.
Calculated,	H_2O	9·10 pr. ct.	Ba 25·41 pr. ct.

The mother liquor from these needles was now evaporated, and in this way a salt of entirely different appearance was obtained. After being recrystallized it formed very regular, beautiful monoclinic crystals, which resembled the known acid sulphobenzoate of barium in every respect. This salt was also analyzed and the same formula found for it as for the needles. The water of crystallization escaped at 200°.

Found,	H_2O	9·34 pr. ct.	Ba	25·56 pr. ct.
Calculated,	H_2O	9·10 pr. ct.	Ba	25·41 pr. ct.

Although the decided difference in the solubility of the salts and in their crystalline form, which constantly presented itself, made it exceedingly improbable, it was still possible that two different conditions of the same salt were here under observation and not two isomeric salts, particularly as the analyses had shown them to contain the same number of molecules of water of crystallization. There was hence still an experiment necessary to prove the isomerism. The two barium salts were converted into the neutral potassium salts and these melted into hydrate of potassium.

The potassium salt that was obtained from the needles, yielded perfectly *pure para-oxybenzoïc acid* as the only product of the reaction. The acid showed all the characteristic signs of para-oxybenzoïc acid. The crystalline form was the same. It contained water of crystallization, which was given off at 100°. Its melting point was exactly 210°. The crystals were very regularly formed and possessed a mother-of-pearl luster.

The nature of the salt that crystallizes in needles is thus explained. It is a salt of *para-sulphobenzoïc acid.*

Acid para-sulphobenzoate of Barium is difficultly soluble in hot water (much more so than the known corresponding salt of meta-sulphobenzoïc acid), and almost insoluble in cold water. When pure it crystallizes from a hot solution during the process of filtering. If it be now redissolved and allowed to stand quietly, beautiful flattened needles are found in the solution, which fill the entire vessel from top to bottom.

The *neutral potassium salt* is very easily soluble in hot, as well as in cold water, and crystallizes from its concentrated solution in needles. Owing to a want of material it was not analyzed.

The potassium salt, obtained from the monoclinic barium salt, on being fused with hydrate of potassium, yielded only oxybenzoic acid, as anticipated.

The principal product of the action of sulphuric acid on benzoic acid is then meta-sulphobenzoïc* acid, while at the same time there is produced in all cases a certain amount of the para acid. As may be seen from the experiments described, there are conditions which are just as favorable for the production of the para-acid as for that of the meta-acid. I have as yet however but once succeeded in meeting these conditions, notwithstanding the fact that a large number of experiments were made with this object. I first repeated the preparation of sulphobenzoïc acid, retaining as closely as possible the conditions under which the first preparation took place; the chief product was not the para- but the meta-acid. Owing to this want of success I have not been able to study the properties of para-sulphobenzoïc acid better. Although its formation was proven under all and the most varied circumstances, the quantity was too small and its separation too difficult to admit of isolation. When present in larger quantity than the meta-acid, as was the case in the experiment mentioned above, the separation by means of the acid barium salts is very simple. If, however, the meta-salt predominates, on evaporating the mother liquor from the first crystallization both salts crystallize out together, forming crystals entirely different from either of the pure salts, and these may be recrystallized repeatedly without effecting their separation into their components.

I am continuing my experiments with the object of discovering the conditions of the formation of the para-acid. At the same time I shall attempt to prepare the same acid by the oxidation of para-sulphotoluolic acid, and will probably soon be able to report on its properties more exhaustively.

Tübingen, May 16.

II. Geology and Natural History.

1. *Mineral silicates in Fossils;* by T. Sterry Hunt. (Communicated).—Since the discovery of a mineral silicate injecting fossils in a paleozoic limestone from New Brunswick, Dr. Dawson has examined a great many limestones from different localities, to obtain further facts which might serve to throw light on the history of Eozoon. A remarkable example of a similar phenomenon has been found by him in a limestone from the collection of the late Dr. Holmer, marked Llangedoe (Wales), and preserved in the Museum of McGill College. The rock is granular crystalline, and made up of organic remains, chiefly fragmentary, for the most part infiltrated by a silicate similar to that from Pole Hill, New Brunswick. The only perfect fossil detected by Dr. Dawson

* Meta = 1·3.

is a small coral-like body referable to the genus Verticillopora, an Upper Silurian form. The limestone includes besides, however, joints and plates of crinoids, small spiral gasteropod shells, with fragments of brachiopods and of a sponge-like organism with square meshes. All of these fossils are more or less penetrated with a greenish silicate, which fills the cavities of the gasteropods, the central canal of the crinoids and the pores of the Verticillopora. It has also replaced or filled the spongy fibers and injected the minute cells of some of the crinoidal fragments, though many of these are solid and calcareous throughout, in which respect the specimen differs from that from New Brunswick, described in this Journal for May, 1871 (p. 379), where the infiltration of the crinoidal remains is much more complete and perfect. Dr. Dawson, to whom we owe these observations, supposes that in both cases the infiltration took place while the remains were still recent.

Decalcified surfaces of the limestone show similar appearances to those presented by the New Brunswick specimens; the casts of small shells like Murschisonia, two millimeters in length, are in some cases perfect. The limestone is nearly pure, with the exception of a little fine yellow ochreous mud, which is insoluble in dilute hydrochloric acid, and remains suspended in the solution, but is easily separated by washing from the pale greenish-gray silicate. This equals about three per cent of the weight of the limestone. When ignited in the air it assumes a bright fawn color, and under the microscope then contrasts strongly with the colorless grains of quartz or other hard siliceous minerals with which it is mixed. Its analysis by Mr. Sterry Hunt in the manner described for the New Brunswick mineral shows that it scarcely differs from this except in being more hydrated and almost identical with jollyte. It gave, after deducting 21·0 per cent of insoluble sand, the following composition for one hundred parts: Silica 35·32, alumina 22·66, protoxide of iron 21·42, magnesia 6·98, potash 1·49, soda 0·67, water 11·46 = 100·00.

2. *Mastodon remains in Central New York;* by B. G. Wilder. (Communicated.)—Five teeth and many bones and fragments of the Mastodon have been discovered in a deposit of modified drift near Ithaca, New York, and placed in the Museum of Cornell University. Many more remains will doubtless be obtained, as the teeth already indicate the existence of two or more individuals; little hope is entertained, however, of finding a perfect skeleton.

3. *Fucoids in the Coal measures of Iowa.*—Prof. White, in his "Geology of Iowa" (vol. i, p. 241), notices the occurrence of forms identical with or allied to *Caulerpites marginatus*, in the Lower Coal-measures of Wapello county, Iowa, and of other forms, more or less indistinct, in the higher portions of the series (see p. 281, l. 4). F. H. B.

4. *Phosphatic Sand in South Carolina.*—Prof. C. U. Shepard has described a deposit of sand over the phosphatic nodular bed of Stone River, which has resulted from the wear of the latter by the waters, and in some places is at least six feet thick. A portion

of it, after drying in the air, was found to contain 27 p. c. of the phosphate of lime, with 63·5 of fine (nearly impalpable) and coarse sand, 3·0 of carbonate and sulphate of lime, 6·5 moisture and organic matter. By agitation in water the lighter flocculent siliceous part may be floated off, and the phosphatic portion thus concentrated to 37 per cent of the remainder. Prof. Shepard observes that this sand deposit appears to be very extensive. He suggests that it may require, after washing, to be treated with sulphuric acid, at the rate perhaps of 100 pounds to the ton; the phosphoric acid would thus be rendered partially soluble. He observes that the phosphate is in too impure a state for railroad exportation, but "for use on lands contiguous to water its future value cannot be doubted."—*Rural Carolinian*, May, 1871.

5. Coues *on Antero-posterior Symmetry.**—That the anterior and posterior limbs of vertebrates are homologous is now admitted by all; but the majority of anatomists hold that they are to be compared as *parallel* parts, while a few † believe that they should be compared as symmetrical or antagonistic parts, as are the right and left sides; the former relation may be called "Syntropy," the latter, "Antitropy;" and the advocates of these ideas, "Syntropists" and "Antitropists" respectively.

The latter have lately been joined by a vigorous ally, to whose work attention has already been called;‡ and the accession is the more opportune because some recent English writers ‖ upon intermembral homologies have regarded the question as already decided in favor of Syntropy, and in the determination of muscular homologies they take for granted that pollex (thumb) is the homologue of primus (great toe), whereas the antitropists above mentioned regard the relation between them as one of analogy only, the pollex being the true homologue of quintus (little toe) and the primus of minimus (little finger). The propriety of this view is admirably presented by Wyman,§ together with the obvious objections thereto and the grounds upon which these objections may be removed.¶

* Antero-posterior Symmetry with special reference to the Muscles of the Limbs; by Elliott Coues, M.D., Assist. Surg. U. S. A.; New York Medical Record, July, 1870, et seq., pp. 149–152, 193–195, 222–224, 272–274, 297–299, 370–372, 390–391, 438–440.

† Agassiz, Dana, Foltz, Wyman and the writer.

‡ American Naturalist, May, 1871.

‖ Flower, Humphrey, Mivart, Rolleston.

§ Symmetry and Homology in Limbs, Proc. Bost. Soc. Nat. Hist., June 5th, 1867.

¶ The general and special questions here involved have been discussed by me at several times since they were first suggested to me by a verbal communication of Prof. Wyman to the Bost. Soc. Nat. Hist., June 6th, 1860: and I shall shortly publish a somewhat extended paper upon the subject, (Proc. Bost. Soc. Nat. Hist., Apr. 19th, 1871) containing the following:

1. An historical sketch of the question. 2. A revision of the nomenclature of parts. 3. A revision of the nomenclature of ideas. 4. Evidence as to the morphical inconsequence of numerical composition. 5. Indication of general problems. 6. Indication of special problems. 7. Chronological list of 76 special works upon intermembral homologies. 8. Alphabetical list of 227 collateral works.

Dr. Coues follows closely in the footsteps of his distinguished predecessor, "not blindly, but unable not to see the validity of his arguments," (195) and therefore, with a few minor differences or doubts respecting details, adopts the osseous homologies of Wyman as the basis for the determination of "muscular correspondences." In respect to these latter, although Dr. Coues is led to differ materially upon some points from my own previous conclusions, yet he has generally shown such good reason therefor, that my praise of this part of his work is unqualified, and I am anxious to go over the whole ground anew in the light of his able discussion. To consider his arguments and conclusions in detail would require a paper equal in length to his own, and I reserve this task for some future occasion when his later and most instructive paper upon the myology of Ornithorhynchus can be included; the general and special problems involved are discussed at some length in the paper already referred to.

But while ready to express the most hearty admiration of Dr. Coues' labors, and confidence in his ability to even surpass them in future, I am forced to criticise some of his methods. In the first place he has "no acknowledgments to make" excepting to three* (149), and therefore, whatever satisfaction may be derived from having so taken up the subject fresh, he has also lost the benefit of the checks which an acquaintance with many and different views exerts upon the tendency to the exclusive adoption of any one; and he has thus, as it seems to me, been led to adopt a faulty method from each of his predecessors.

He has unconsciously imitated Owen in the use of many different and often ponderous expressions for the same idea "in order to avoid monotony,"† whereas, in homologies, as in mathematics, each object and idea should be known by a single term, and by that alone; since, of all the natural sciences, this demands the closest attention, and the absence of all secondary considerations.

Dr. Coues has accepted unquestioned the view of the normal position of the membra for comparison which was first proposed by Wyman, and adopted by Foltz, Folsom and myself; this view is based upon the proposition of Wyman, (op. cit. 265) that "the knees and elbows in all animals are bent so as to form angles pointing in opposite directions;" if we except the fishes, this generalization is correct, *provided* the membra are placed in the position they have with most quadrupeds; but Goodsir, Humphrey, Huxley and Wyman himself have shown that this is not their *primary* position, and it is quite possible that Wyman and Coues might have followed Huxley in denying that it is their *normal* position, had they read his paper; the desire to admit this radical change in my own views upon this point was one of the chief motives for the preparation of the paper already referred to, since do-

* Owen, Wyman and the writer.

† As for instance, "*two-jointed* thumb" is coupled with "*biarticulated* great toe." p. 193; and in a few cases there is tautology, as in "morphologically homologous" and "teleologically analogous," p. 194.

ing so involves a concession, though not essential one to the idea of syntropy.

Finally, Dr. Coues has accepted from the writer a nomenclature of ideas, (Antitypy, &c.,) which was itself based upon Owenian phraseology, which was in no way expressive of the ideas designated thereby, and which I now propose to discard for a more significant nomenclature derived from a term (Antitropy) already in use. I have commented upon some of Dr. Coues' methods the more freely, in part because of my unqualified admiration of his real individual work, but chiefly because as regards the use of many and long words, and the acceptance of the peculiar views of single authors, my own sins have been more and greater than his can ever be. B. G. W.

6. *Supplement to "Annélides chétopodes du Golfe de Naples."* —Claparède has published a Supplement to the Annelids of the Gulf of Naples especially interesting for its complete observations on the singular phenomena of reproduction of the Nereids, which were barely suspected at the time the principal part of his monograph appeared.

Malmgren in 1864 was first led to suspect a genetic relation between Nereis and Heteronereis, from a comparison of *Nereis pelasgica* and *Heteronereis grandifolia*, showing nearly an absolute identity, with the exception of the peculiar foliaceous appendages and bristles of the posterior part and other minor characters only developed at the period of sexual maturity. This led him to look upon certain species of Nereis as the agamous stock of sexual individuals appearing as Heteronereis. Subsequently having found eggs in this presumed agamous Heteronereis stock, he came to the conclusion that, although all the species of Iphinereis and Heteronereis were only sexual forms in series of generations still unknown, yet that at some time, during sexual maturity a stage of one of the polymorphous species of Nereis assumes the characters of Heteronereis, to lose them subsequently and return to its agamous stage. Malmgren accounted for the genetic relations by an alternate generation at first, and afterwards by a metamorphosis; both of which hypotheses Claparède shows conclusively are justifiable. Ehlers has shown that a large number of species of Heteronereis were only sexual forms of previously known species of Nereis, and interprets these facts in favor of a metamorphosis of Nereis into Heteronereis.

This was the condition of the problem when Claparède resumed the subject and showed conclusively (from the study of living Annelids) that there is a genetic relation between Nereis and Heteronereis, but he shows as conclusively that all Nereids do not have their Heteronereis form, as had been taken for granted by Ehlers, and that there is in the Annelids of this family a polymorphism almost without parallel in the animal kingdom. Taking the species which he has most carefully studied (*Nereis* (*Leontis*) *Dumerillii*) we have first a sexual form as Nereis, two sexual forms as Heteronereis, and a fourth hemaphrodite form discovered

by Mecznikow. Large full grown specimens of *Nereis Dumerillii* are all transformed into Heteronereis, while the small diminutive individuals alone become matured as Nereis. Of the two sexual forms of Heteronereis one is small, extremely active, swimming freely about and eminently pelasgic, the other is sluggish, remaining more or less stationary at the bottom of the sea. The variations in size of individuals becoming sexual as Nereis or changing into Heteronereis are considerable, and it may be that a species can arrive at maturity in all stages of growth, may subsequently lose all traces of its sexuality, increase in size and in number of segments, to take on late again sexual characters and be transformed into Heteronereis. Absolute certainty of the sequence of these changes can only be obtained by tracing them in an aquarium.

This Supplement is illustrated by fourteen excellent plates, completing data left more or less imperfect in the first part. There are excellent observations, and figures, on the eyes of Alciopidæ, confirmatory of former papers by Krohn and Leydig on the same subject, adding many new points of considerable physiological importance. In the preface, Claparède promises us an extended memoir on the histology of Annelids (for which he has many thousand admirable preparations), he calls attention to the restoration of many specific names first introduced by Delle Chiaje which have usually been neglected. As a mark of his appreciation of Delle Chiaje's work he fittingly dedicates to him the closing chapters of this excellent contribution to the fauna of the Bay, where he worked so long and so successfully. A. AG.

7. *Diapensiaceæ.*—To the account of this small group of plants, as given in a paper entitled: "*Reconstruction of the order Diapensiaceæ*, presented to the American Academy in June, 1870, and issued at the close of the year, Dr. Maximowicz, in the ninth decade of his *Mélanges Biologiques*, published by the St. Petersburgh Academy this spring, has added some interesting comments and observations. He first remarks that he not only approves of the association of *Schizocodon* and *Galax* with *Diapensia*, but had himself suggested it in the year 1867, in a letter to Prof. Bunge, who had responded in favor of the suggestion. He also now concludes that both *Shortia* and *Shizocodon* are probably to be maintained as genera; the former including *Schizocodon uniflorus* as a second species is most likely distinct from the Alleghanian plant and clearly different from *Schizocodon soldanelloides*. This opinion is grounded mainly upon a drawing, which apparently represents the plant in question, in a Japanese work in his possession, and which exhibits the corolla, this, curiously enough, being wanting in the about 30 known specimens of the Japanese plant, as well as in the solitary American specimen. The closely adherent testa of the seed and the slender style are the most marked characters.

In the same publication Dr. Maximowicz characterizes a remarkable new Japanese genus, *Ellisiophyllum* (so named from the like-

ness of the leaves to those of *Ellisia*) which is intermediate between *Hydrophyllacea* and *Polomoniaceæ*. The habit, dicarpillary ovary hirsute at apex, and imbricated petals are suggestive of the former order; but the undivided style, central placentation, and especially the mucilaginous seed-coat, place it rather in the latter.

Dr. Maximowicz, moreover, has ascertained that our *Euodia ramiflora* is Thunberg's *Orixa Japonica*, of which only male flowers were known; and he restores that genus, referring it to the neighborhood of *Euodia*. A. G.

8. *Form and Sculpture of Seeds.*—Prof. Lange of Copenhagen has published, in *Botanisk Tidsskrift*, 1870 (in Danish) an interesting paper upon this subject, which, as botanists know, often furnishes excellent characters to distinguish otherwise similar species. He treats here of *Pyrolaceæ*, *Droseraceæ*, *Cerastium*, and especially of *Pedicularis*, with illustrations. In two plates, filled with beautiful colored figures, the seeds of 25 species of *Pedicularis* are strikingly depicted. A. G.

9. *Hypocotyledonary Gemmation* is of uncommon occurrence. My attention has been called, by Mr. Guerineau, the gardener of the Cambridge Botanic Garden, to a remarkable instance, which occurs in all our seedlings of *Delphinium nudicaule*, the unique red or red-and-yellow-flowered species of California. As this species is now in European cultivation, and a probable variety of it, *D. Cardinale* was raised and figured in England several years ago, the peculiarity in question is likely to have been noted; but I have seen no account of it. In germination, the slender radicle elevates a pair of well-formed ovate cotyledons in the usual way. These acquire full development; but no plumule appears between them; consequently the primary axis is here arrested. Soon a nassiform thickening is formed underground at the junction of the lower end of the radicle with the true root: from this is produced a slender-petaled 3-lobed leaf, which comes up by the side of the primary plantlet; soon a second leaf appears, and so on, setting up the permanent axis of the plant from a bud which thus originates from the very base of a well-developed radicle, if not from the root itself. A. G.

III. Astronomy.

1. *A remarkable Meteor;* by R. H. Thurston, U. S. N. (Communicated.)—While standing on the deck of the steamer "Electra," last evening, *en route* from Providence to New York, I was startled by a sudden flash of bright blue light which illuminated the whole heavens and was instantaneously succeeded by an equally intense red flash which again gave place to blue. Turning suddenly, I saw a falling meteor, which was, so far as my knowledge extends, unique.

It exhibited a nucleus of blue, with a long flame-like train also blue in color except on the south side where a portion, equal to perhaps one-third of the whole, was of a brilliant red.

The height of the meteor, at disappearance, was about 29° above the horizon, its bearing nearly due east from Watch Hill Light, and the time, at that place, not far from 9:15 P. M. It was about 25′ in length, and 5′ in width, moving directly downward.

Stevens' Institute of Technology, Hoboken, N. J., June 15th, 1871.

IV. Miscellaneous Scientific Intelligence.

1. *On the influence of a covering of Snow on Climate;* by A. Wojeikof, Member of the Imp. Russ. Geogr. Society. (Communicated).—The influence of a layer of snow, resting on the earth's surface in the colder portions of the earth during winter, has, to my knowledge, never been considered in its general bearing on the climate and the conditions of the population living in these countries.

The first and most apparent influence of snow is the protection it affords to our crops from the cold of winter. Where the snow-mantle appears regularly, winter-crops are always sure, be the cold ever so intense. In the steppes of south and east Russia, where little snow falls in winter, and this small quantity is often blown away by the strong winds, winter crops are scarcely attempted at all. On the northern coasts of the Black Sea, summer wheat and Indian corn are very good, but winter wheat is a precarious crop, while to the north, in Podolia, it is the principal crop. There the forests afford a protection against the wind, the snow falls more copiously and cannot be blown away.

As a bad conductor of heat, the snow isolates the warmer soil from the cold air above, and there is no doubt that it renders also the winter cold more intense, as the air cannot receive heat from below. In countries where the snow-covering is not permanent, as Western Europe, this influence of snow is well known, and people expect great cold where a layer of snow has fallen and the sky clears. In countries where snow usually lies the whole winter, as Russia and the northern parts of America, this is not generally understood, and in Russia people say it is colder without snow than with it. This feeling is quite natural. The first frosts of autumn are more severely felt because the human body is not accustomed to them, and also because the air is drier than with snow, and a cold, dry wind is more severely felt than a cold moist one.

The great relative humidity of the air is a most important feature of the countries covered with snow in winter. It is as easy to account for it as for the humidity of an island in the middle of the ocean or of a place situated in an extensive swamp-tract. The wind may come from every side; it has always to pass over a large evaporating surface, and absorbs moisture if it was originally dry. In countries where cold strong winds predominate, as in the greater part of N. America and Eastern Asia, this will be less the case, as the winds, rapidly passing over the land, have not the time for absorbing much moisture, and the dryness of the air in the United States is felt by Europeans going there. But in countries situated like Europe and Western Asia, where the cold

winds are usually weak, and only the warm southerly winds strong, the air will be always nearly saturated, when the soil has a snow-covering, as the cold winds, in their slow progress, have the time for absorbing moisture. This feature of climate is extremely important in the examination of storms. It was one of the chief merits of Espy to have pointed out the importance of vapor in the origin and progress of storms, and this is now generally admitted. If a storm is signalized and the beginning of its path stated, it is important to know the quantity of vapor disseminated in the countries where it is likely to pass, and the quantity which may be expected to be condensed as rain and snow. Now, the lower the temperature falls, the more uncertain are observations of the psychrometer, and I am of the opinion that it is not a sure guide below the freezing-point. This stated, it is very important to have some general idea as to the quantity of vapor over the cold spaces of the earth's surface. Now in countries situated like Europe, relative humidity will scarcely fall below 75–80° so long as the earth is covered with snow, so that the quantity of vapor in the air of these regions may be very nearly known if we know the temperature. In an examination of the barometric range in European Russia and Siberia, some time ago, I have stated that not only the pressure of the air rises in winter as we advance from the western coast of Europe into the interior of the continent, but the barometric minima rise even more, so that for example, in Nertschinsk, in Eastern Siberia, the middle barometric minima of January, reduced to the sea-level, are 30·23 in., and the lowest pressure happening in 17 years in this month was equal to 29·93. If we consider that at this place the temperature never rises above 14° F. in January, the effect of cold and small quantity of vapor in the air, in arresting the progress of storms in winter will be clearly seen. In European Russia the barometric minima are lower in winter than in the other seasons. This shows that the storms of the Atlantic take their course over our country. Speaking generally, the path of storms is from N.W. to S.E. in winter, because they cannot advance in an eastward direction as they began, being arrested by the cold. The colder the temperature is, the sooner the storms must turn to the southward, and this will be much more the case in January than in November and March, when the storms of Europe sometimes advance into the interior of Siberia.

Another feature of the snow is that of arresting the progress of temperature above the freezing-point so long as it lies. In rising above, the heat is employed in melting the snow, or in the language of the mechanical theory of heat, it is transformed into work. We have some striking facts of this kind in Russia. For example, Barnaul, in Western Siberia, has a winter temperature lower than St. Petersburg, by nearly 18° F. Yet the thermometer sometimes rises as high as in this last place in winter, because Barnaul has the Kirghi-steppes to the southwest. As they are seldom covered with snow, warm winds can pass across them and without losing

their heat, while before arriving at St. Petersburg, they must lose much of their heat in melting the snow over an extensive track. The result is, that seldom a winter month passes without temperatures above freezing-point, but in January and February the thermometer does not rise above 39°, while at Barnaul a temperature of 42° may occur at that time, (for example on the 4th, 5th and 6th of February, 1855).

I have mentioned already the effect of the snow in checking the rise of temperature, and employing more abundant heat in melting. This is most felt in spring, and lowers much the temperature of this time of the year, as for example, while in Central Europe, at some distance of the sea, April has nearly the same temperature as October, in the same latitude; in Russia the warmth of the sun's rays cannot raise the temperature of the air so much, and April is generally 4° F. colder than October, while May has the same temperature as September. As soon as the snow is melted our climate assumes its true continental character. In more northern parts of Russia it is May which stays behind September; as for example, at Archangel, Berezoe and even Yakutsk in one of the most continental climates of our planet in this last place May is more than 3° colder than September, while March is 13½° *warmer* than November.

I must now state a last point, the influence of forests in equalizing the layer of snow and giving to it all its beneficial effects. Without the forests a great mass of snow is often a check to all communication, as for example, at this moment in South Russia, where most of the railways are stopped. The unusually great mass of snow is blown in all directions by the wind, unimpeded by trees, as some of these places were always steppes, in others man was too short-sighted to let the trees stand. The effect of the melting of snow on the rising of rivers will be quite different in a wooded and a bare country. In the first the snow will lie sometimes a month longer than in the last, and accordingly the floods of the rivers will be longer continued but less high and devastating. Every one who has inhabited the country will be struck by this fact and its bearing on the climate and the well-being of the population all around. Generally speaking, as I have stated, the effects of a layer of snow are beneficent to man. The proportion of the crops is of enormous economical worth. The greater moisture of the air is also good, and even the cold of spring, caused by the melting of snow, has its good side. The too rapid advance of vegetation in early spring is checked by it, and protracted to a time when the vegetables have less to fear from night frosts. Northern Europe, for example, suffers much less from this curse than the south, where the returns of cold in spring cause great damage every year. Only two serious effects are sometimes felt, the interruption of communication in snow storms and the great floods of spring. But both of these drawbacks can be avoided by the foresight of man, as forests arrest the progress of winds and cause a slow melting in spring, so as to store a great quantity of water to supply our rivers.

St. Petersburg, 20th February, 1871.

2. *Scientific Expedition from Williams College.*—The scientific expedition from Williams College, consisting of five members of the present senior class, under the charge of H. M. Myers, which left the States last November for the purpose of making explorations and collections in Central America, returned from that country in March, having successfully accomplished the objects proposed. The party spent some time upon the elevated plain of Comayagua, in Spanish Honduras, where they found the climate most salubrious. One of the immediate results of the expedition is a fine addition to the cabinets of Williams College. The ornithological specimens secured, taken in connection with those added to the museums by the expedition to South America, in 1867, give the college a most valuable collection of tropical birds. Among the additions to the archæological department are two interesting statues exhumed at Corosal, in British Honduras, ninety miles south of Belize. The work upon these images, cut from limestone rock, is quite finely executed; and being still in a good state of preservation, they are valuable and interesting relics, marking the advances in civilization made prior to the occupation of the country by the Spaniards. Although the table-lands and the Pacific coast of these Central American States have been frequently visited by collectors, the low coast-lands of the northern slope have been almost entirely passed by on account of their unhealthfulness. Collections from these comparatively new fields are especially valuable; moreover, the richness of the fauna and flora offer every inducement to the naturalist. It was upon these lowlands that the Williams College party made their largest collections.

3. *Description of a Tide-Gauge for cold climates;* by JOHN M. BATCHELDER, of Cambridge, Mass.—This instrument is intended for registering the height of the tide at stations where the float and box commonly used are liable to be obstructed by ice.

A strong iron tube, about four inches in diameter, is firmly bolted to a wharf or pile. It is open at the top, and has at the lower end a nipple to which an India-rubber bag is fastened,—the length of the tube being sufficient to allow the elastic bag to be always submerged at the lowest stage of the tide.

The bag is supported by a suitable shelf, or cage, and is filled with glycerine, which is poured in at the top of the tube. When in this condition the glycerine rises and falls within the iron tube in proportion to the varying height and pressure of the column of water above the rubber bag, the difference in the height of the two columns being in proportion to the difference of the specific gravity of the water and the glycerine. The parts above described insure protection from floating ice, and prevent congelation within the iron tube.

A copper tube, about three inches in diameter, closed at the bottom, and open at the top, is placed within the iron tube, and floats in the glycerine: if left free it would rise and fall with the changing level of this liquid. The length of the central tube is a little greater than the whole range of the tide.

Near the upper end of the outer tube, there are three spiral springs, fixed at the top and united at the bottom by a plate or disk, from which the central copper tube is suspended. From a stem fixed to the center tube or float, and moving with it, a string or chain leads over a single pulley, and gives horizontal motion to the pencil carriage of the recording apparatus.

The distance that the central tube is to move, vertically, is adjusted to agree with the required range of the pencil upon the record paper, by placing within it suitable weights.

As the glycerine falls or rises in the annular space between the iron tube and the central float, the spiral spring at the top is more or less extended, the extension being uniform on account of the cylindrical form of the float.

It is not necessary that the India-rubber bag be enclosed in a perforated box for the purpose of preventing oscillation: as it is always submerged, and the pressure upon it is equal to the weight of a column of water, having its base at the bag, and its summit at the mean level of the surface waves.

This instrument has been constructed by the United States Coast Survey, and is now in operation at the tidal station in the Boston Navy Yard.

4. *American Weather Notes;* by PLINY EARLE CHASE. (Read before the American Philosophical Society, March 3, 1871.—The signal service observations of our War Department have already shown the value both of Buys Ballot's law and of Capt. Toynbee's modification in predicting changes of wind, especially if due regard is paid to the barometric variations of the two previous days. They have also suggested the following general deductions, some of which may perhaps prove to be true only of the winter, while others seem to be explicable by natural circumstances of position and physical configuration, which must be operative at all seasons.

(1.) Winds varying like the land and sea breezes, are often traceable, especially in the lull which follows the passage of storms, to differences of temperature in the neighborhood of the great lakes, and of mountain peaks and ridges.

(2.) The wind, especially in the Southern States, often blows directly in the line of the greatest barometric gradient. But even in such cases, after a few hours continuance, it tends toward the azimuth indicated by Buys Ballot's law.

(3.) The isobaric lines are, therefore, often of less relative importance than the gradients in forming forecasts.

(4.) Long ridges of high barometer, as observed by Espy and others, with adjacent troughs of low barometer, often traverse the continent, sometimes with slight deflection, sometimes having a semi-circular, circular, or elliptical curvature, with a diameter of three thousand miles or more. Such ridges usually have a steeper declivity and stronger winds on their northerly and easterly than on their southerly and westerly sides.

(5.) Currents with an anti-cyclonic tendency, controlled by areas of high barometer, are notably common. Reversals of wind, as from N.E. to S.W., are, therefore, frequent after the passage of

an anti-cyclonic ridge or center, as well as after the passage of a cyclone.

(6.) Our recent storms have been anti-cyclonic, and there seems some reason for supposing that anti-cyclones are the usual "weather-breeders," even of such of our land storms as become more or less cyclonic after they are fully developed.

(7.) The precipitation of vapor of course gives rise to local cyclones, which, however, may be easily and speedily overborne by the grand anti-cyclonic whirls of a half million miles or more in area.

(8.) These and other peculiarities, point to a probable origin of storms in the blending of polar and equatorial currents, near the latitudes at which the general tendency of the winds changes its direction.

(9.) Mr. Scott has observed that when polar (E.) currents are blowing at the North, and equatorial (W.) currents at the South, a serious barometrical disturbance, frequently resulting in a gale, generally soon follows; but when the polar current is at the South and the Equatorial at the North there appears to be no law of sequence. The latter condition, with us, seems often indicative of approaching fair weather, especially if northerly or easterly are separated from southerly or westerly winds by a ridge of high barometer.

(10.) If the progress of a northerly or easterly current toward the equator is impeded by an intervening southerly or westerly current, the disturbance not only speedily follows, as indicated by Mr. Scott, but it is also, commonly, like most showers, S.E. storms, and other marked cyclonic commotions, of briefer duration than those which are primarily anti-cyclonic.

5. *European and American Rain-falls;* by PLINY EARLE CHASE. (Read before the American Philosophical Society, March 3, 1871.)—There is still a lingering skepticism on the part of some meteorologists, regarding the moon's influence on the weather, a skepticism which is perhaps owing to the apparent want of agreement between observations at different places. There is, however, no good reason for expecting such accurate correspondence as is sometimes deemed essential. Dr. Emerson (Proc. A. P. S., xi, 518) has communicated to the Society his early observation upon the reversal of the European Barometric prognostics on this side of the Atlantic. Mr. Blodget (Climatology, pp. 221–237) has pointed out various climatologic contrasts, and Mr. Scott, the Director of the British Meteorological Office, has noticed an opposition between the solar (or temperature) rain-falls in Western Europe and Eastern America, analogous to that which I have indicated in the lunar rain-falls. The confirmation thus afforded to the results of my previous investigations, strengthens the presumption that, in our Atlantic States, signs of fair weather may be most confidently trusted during the ten days preceding, signs of rain during the eight days following, full moon.

In order to make a comparison between stations of similar latitude, I obtained from the "Observatorio do Infante D. Luiz," a

record of the quarterly rains at Lisbon for sixteen years, which I have embodied, together with the observations at Pennsylvania Hospital for the same period, in the following tables. The measurements are given in millimeters.

I.—*Quarterly Rain-fall at Lisbon.*

Years.	Winter.	Spring.	Summer.	Autumn.	Total
1855	280·3	272·7	15·4	362·5	930·9
1856	513·4	300·7	8·5	90·3	912·9
1857	267·8	152·2	67·9	324·4	812·3
1858	224·2	113·2	7·1	567·6	912·1
1859	128·0	201·8	71·6	306·9	708·3
1860	210·9	122·4	39·6	187·3	560·2
1861	501·5	154·3	14·6	311·4	981·8
1862	364·4	282·9	6·6	176·9	830·8
1863	181·8	196·6	64·8	101·6	544·7
1864	155·3	282·2	33·9	363·5	834·9
1865	371·6	159·2	24·4	487·2	1042·4
1866	214·7	365·3	14·6	82·3	676·9
1867	197·2	216·2	13·6	172·1	599·1
1868	162·9	76·9	38·0	279·4	557·2
1869	323·2	158·5	3·1	66·0	550·9
1870	305·7	111·6	21·9	160·3	599·5
Mean	275·2	197·9	27·9	252·5	753·4

II.—*Quarterly Rain-fall at Philadelphia.*

Years.	Winter.	Spring.	Summer.	Autumn.	Total.
1855	193·0	169·9	435·4	257·8	1056·1
1856	284·5	211·8	241·3	187·5	925·1
1857	184·4	359·9	482·6	133·4	1160·3
1858	264·9	272·8	274·1	227·1	1038·9
1859	376·7	376·9	376·4	371·6	1501·6
1860	240·3	229·6	311·7	342·9	1124·5
1861	269·8	362·5	243·3	332·0	1207·6
1862	292·6	254·5	263·1	343·9	1154·1
1863	280·7	442·0	297·4	153·4	1173·5
1864	174·8	448·3	204·2	327·9	1155·3
1865	370·1	374·7	291·9	380·3	1416·9
1866	390·4	247·9	194·6	370·9	1203·8
1867	230·1	370·6	742·5	228·1	1571·3
1868	225·3	401·3	268·0	404·6	1299·2
1869	318·5	296·2	247·7	337·8	1200·2
1870	297·7	404·9	303·8	195·8	1202·2
Mean	274·6	326·5	323·6	287·2	1211·9

It appears, therefore, that the heaviest rain-falls at Lisbon and the lightest at Philadelphia, are usually in the Autumn and Winter semester; the heaviest at Philadelphia and the lightest at Lisbon, in the Spring and Summer. In ten years out of the sixteen, when the rain-fall of the entire year was above the average at one station, it was below the average at the other.

6. *Discovery of the Animal of the Spongiadæ confirmed;* By H. J. Carter, F.R.S. &c. (Ann. Mag. N. H. IV, vii, 445). Just a line to tell you what you will be glad to learn, viz. that I have confirmed all that Prof. James-Clark, of Boston, has stated about the sponge-cell, and much more too.

It is, after all, only what was published and illustrated in the 'Annals' in 1857. Indeed I am astonished now at the accuracy and detail of that paper ("Ultimate Structure of Spongilla," &c.), now *all* confirmed by an examination of a *marine* calcareous sponge.

I have not only fed the sponge with indigo, and examined all at the moment, but the sponge so fed was put into spirit directly afterward, and *now* shows all the cells (monociliated) with the *cilium attached and the indigo still in the cells.*

This, I think, will break down Häckel's hypothesis, which is as imaginative and incorrect as it is beautiful.

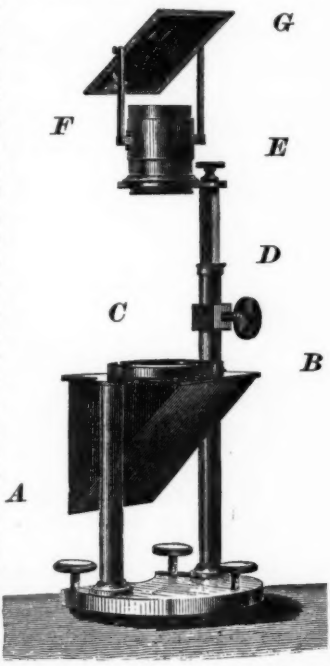
His "Magosphæra," too, is figured in the 'Annals' (1856), and described *in extenso* as the amœboid cell which inhabits the mucus of the cells or internodes of the Bombay great *Nitella.*

But there are no people in England, if on the Continent, who seem to be able to show this, if even they be cognizant of it.

Ex oriente lux used to be the old phrase; the light is now being *reflected* back from America. It is from there that we must expect novelties now.

"The Cottage," Budleigh-Salterton, May 22, 1871.

7. *A new attachment for the Lantern.*—It is often desirable to throw upon a screen the images of objects which must be preserved in a horizontal position; such for example as liquids, or solids immersed in liquids. Various devices have been tried for securing this end: all of them more or less imperfect. Recently, however, President Morton, of the Stevens Technological Institute at Hoboken, has devised a form of apparatus for this purpose which is quite simple and ingenious, and which answers its purpose admirably. This "vertical lantern" as he calls it, is shown in the accompanying figure. It is to be placed in front of the ordinary lantern-box, the condenser being composed of three lenses; the first two of these being of such a curve as to give, with the light about two inches from the nearer one, a practically parallel beam. This beam enters the apparatus at A, is received upon a mirror inclined 45°, which reflects it vertically through the third lens placed horizontally at C. This lens concentrates the beam upon the object glass at E, after passing which, it is reflected upon the screen by the silvered mirror FG. Though the lenses are all of them uncorrected, and the mirrors silvered on the back in the ordinary way with pure silver, yet there is no want of definition in the images produced, and the color is too slight to be appreciable by an audience. We witnessed the performance of the instrument a short time ago with great satisfaction. A glass plate, evenly covered with iron-filings, being placed above the lens C, a small magnet was laid beneath it, and the plate gently tapped with a pencil. The filings gradually arranged themselves in the well-known curves, producing finally a magnetic spectrum of great beauty. A shallow tank of water being then placed in the same position, the images of waves, ingeniously produced by puffs of air, were thrown upon the screen, and the various phenomena of interference and reflexion beautifully illustrated. Tomlinson's cohesion figures, produced by allowing drops of various essential oils to fall upon water, were also superbly demonstrated. By using thin glass plates covered with sand, Chladni's sound figures may in this way be developed upon the screen in a striking manner.



The apparatus was manufactured by Messrs. Hawkins & Wale of Hoboken. It is exceedingly creditable to them in the excellence of its construction and finish. G. F. B.

8. *Report on Barracks and Hospitals, with descriptions of Military Posts.* 4to, pp. 494.—Under the modest heading of "Circular No. 4," the Surgeon General's office of the U. S. War Department at Washington has issued a valuable document with the above title, containing a great amount of valuable information respecting distant outposts but little known, geographical, topographical, meteorological, sanitary, &c.

In an appendix are "Reports on Examination of Air in Barrack rooms," giving the results of chemical analysis of the air at night

Tabular Statement of four Analyses of Air in Military Barracks, made by Capt. Lorenzo Louvain, assisted by Lieut. John Pitman, and reported by Surgeon V. B. Hubbard.

Experiment.	Time of observation.	Tempt. Fh.	Apartment.	Contents.		Estimation of carbonic acid.		Estimation of organic matter.		Superficial area of door & windo's open at the time in feet.
				Men.	Cubic feet of air.	Volume of air examined in c. c.	Volumes of CO_2 found in 10,000 vols.	Vol. of air examined in c. c.	Organic in 1000 c. c. of air.	
1	1.30 A. M., July 22, '70.	81°	Artillery barrack.	19	13,016·25	3700	9·58	34·091	·00440	131·75
2	3 A. M., July 22, '70.	78°	Cavalry barrack.	16	16,803·36	4340	9·30	34·092	·00292	111
3	2 A. M., July 26, '70.	85°	Engineer barrack.	9	6,296	----	9·37	----	·00343	63
4	2 A. M., July 28, '70.	77°	Cadet hospital.	4	4,480	---	5·68 5·52	----	·00187	73·35

in barracks occupied by sleeping soldiers. Assistant Surgeon V. B. Hubbard reports four analyses of air from the apartments of the U. S. Military Academy at West Point, N. Y., made by the Captain and his assistant, which we have arranged in a tabular form for convenience of comparison. B. S.

9. *Captain Hall's Arctic Expedition.*—The Polaris, the vessel for the Arctic Expedition under Captain Hall, is now in New York (June 15), at the Navy Yard in Brooklyn, where she will remain ten days, or until ready to start northward. She will take in supplies to last to Disco in Greenland, where she will await the arrival of the storeship Supply, with additional provisions. Captain Hall contemplates an absence of two years and a half, and if results warrant, the voyage may be still farther prolonged. From Disco the expedition will proceed to Uppernavik or Tissonack, the most northern settlement of Greenland, where gangs of dogs will be obtained. The Polaris may have to winter in Jones' Sound, the latitude 76°N., but if possible will be pushed on to 80°N. Early in April, 1872, the journey over the ice toward the Pole will be begun. Hall asserts that if Ellesmere Land, which reaches from Jones' Sound northward, extends upward to the Pole, he is confident of reaching the great object of his destination in at least 100 days from the time he leaves the ship with his boats and sledding party. Should the land and ice termimate in an open Polar sea, his boats will be used on that as yet mythical sheet of water to complete his discoveries, precisely in the same manner as they will be employed in transporting the party from

one flöe to the other whilst among the field ice. The chief of the scientific corps attached to the expedition is Dr. Emil Bissels, who was a member of the recent Prussian expedition to the North Pole. He is a young man with a high reputation as a scientific student, and is a graduate of the famous University of Heidelberg.

Besides Capt. Hall and Dr. Bissels, quite prominent characters are the sailing-master, Capt. O. S. Buddington, who has had thirty-two years' experience as an Arctic navigator, Mr. Hubbard C. Chester, of Noank, Conn., the first officer, and Mr. William Morton, who is said to have discovered the open Polar Sea while on the first Grinnell Expedition, who goes out as the second officer. Sergt. Meyer, of the United States Signal Corps, has charge of the meteorological department. R. W. D. Bryan is astronomer.

Two of the most interesting individuals who accompany the expedition, are the Esquimaux man and woman, who have been with Capt. Hall since his first essay in Arctic explorations.—*New York Times*, June 15.

10. *The so-called "Cardiff Giant."*—It will be remembered that, two or three years since, a considerable excitement was created by the alleged accidental discovery upon the farm of a Mr. Newell, near the city of Syracuse in the State of New York, of a human figure of gigantic proportions, which was exposed during an excavation undertaken by the owner with the avowed purpose of digging a well for the supply of water to his cattle. The obvious folly of excavating for a well in the bed of a stream of water was commented on at the time and was not easily explained away. The popular appetite for marvels was, however, adroitly quickened by the story first of a "fossil man," of pre-historic age; for who did not believe that "there were giants in those times?" The absurdity of such a theory soon compelled the milder statement that while the recumbent giant was of acknowledged human origin, it was unquestionably of an unknown but very high antiquity, and hence must possess great archæological interest. With this hypothesis the so-called "Cardiff Giant" commenced his tour of exhibition, after thousands of curious spectators had visited him in his resting place as he lay exposed in the excavation upon the Newell farm: and for a time multitudes thronged the places in various cities where this supposed relic of an earlier age was to be seen. We have lately had the matter brought home to our own doors through a visit of this venerable personage to New Haven, and although we had supposed the fraud had long since ceased to be capable of exciting more than a feeling of contempt, mingled with curiosity to see by what means the delusion was produced, we have been surprised at the facility with which people, otherwise sensible, give credit to the greatest absurdities, even after the "humbug" had been fully exposed. We think therefore it is worth while to record very briefly the real history of this sham, that it may find its place in the already large catalogue of popular delusions. We suppress names, but give the main facts as we have ascertained them from an in-

telligent witness who was cognizant of the origin and progress of the statue.

The block of gypsum, from which the Cardiff Giant was carved, was quarried near Fort Dodge, in Iowa, where there is an inexhaustible supply of massive gypsum of Mesozoic age.* It was transported to Chicago, in Illinois, where it was placed in the workshop of Mr. Burckhardt, a well-known marble-worker of that city, who contracted with the originators of the scheme for a not very considerable sum of money, to produce a gigantic recumbent figure of a man. His position, resting with the left arm under the body, the right arm thrown across the body over the pelvis, and with the legs slightly flexed at the knees, was measurably a necessity of the form of the block of stone at the artist's command. This figure was first modeled in clay by or under the direction of Mr. Burckhardt, and was then transferred to the stone. Our informant states that he saw the figure more than once during its preparation. The appearance of age was given partly by treating the surface with acids to remove the tool marks and the raw look of a recently tooled surface, and this effect was subsequently heightened by the grime and soil of a seven months' interment. Thus prepared, the newly-made antique was transported by rail to a point near the Newell farm, and thence by teams to the farm itself, where, by the aid of a body of work people, brought from a distance, it was placed in its resting place, near the bed of a small stream. Those engaged in the work of removal and interment were taken away furtively, and thus no one at or near Syracuse but those engaged in the speculation knew of its existence. By a singular accident, an eye-witness to its making in the Chicago work-shop happened to be in Syracuse at the time its discovery was announced, and, visiting the Newell farm with the crowd of curious spectators, was surprised to see there his old acquaintance half buried in the earth. We have taken pains to verify this statement, and are promised at an early day a detailed statement from the work shop of Mr. Burckhardt of its entire history, which we may take another occasion to publish. B. S.

11. *Party of Exploration under Dr. Hayden.*—Dr. Hayden and party (as a letter from him informs us) were at Ogden, Utah, on June 8th. The party comprises thirty-two men (including an astronomer, topographical engineer, etc.), five wagons, two ambulances, forty-eight mules and horses. He proposes to connect with the belt under exploration by Clarence King, and then spend the remainder of the season about the sources of the Yellow Stone and Missouri rivers. He has a boat and sounding apparatus for making a complete survey of the Yellow Stone, etc. A company of cavalry is ordered as an escort from Fort Ellis. He expects to return to Washington about the 1st of November. Congress made an appropriation of $40,000 for the explorations of the season.

* See Dr. White's report on the Geology of Iowa, vol. ii, p. 299.

12. *Survey of the Great Lakes.*—We take the following notes on this survey from Harper's Weekly of June 10th, a periodical which has in each number one or two columns of recent scientific intelligence furnished by a correspondent who is a man of thorough science, and in the way of knowing what is doing in science.

"Among the United States government explorations to be prosecuted during the present year, we should not omit to mention that of the Lake Survey under the Engineer Bureau. This work has been in progress for a number of years, and in the reliability of the observation and the beauty of the maps published occupies the very first rank. The work is at present under the charge of General C. B. Comstock, and will be carried on in several localities simultaneously. The survey of Lake St. Clair, which was nearly finished last year, will be completed the present season; and the party, on finishing it, will then proceed to the St. Lawrence River, in the neighborhood of Ogdensburg, and there carry on their labors. Both shores of Lake Michigan will be surveyed during the season, commencing at Sheboygan on the eastern shore, and at a point north of Grand Haven on the western. It is expected that the whole will be completed as far south as Kenosha before operations are interrupted for the winter. Triangulations will be conducted along Lake Michigan between Green Bay and Milwaukee. In addition to the hydrographical and surveying work prosecuted by these parties, great attention is paid to securing reliable data in regard to the meteorology of the country, with the special view of determining the average conditions of rain-fall and other phenomena.

"The data already collected have been of great value, and have done much toward supplying accurate information."

13. *Geological Survey of Canada:* Alfred R. C. Selwyn, *Director.*—Report of Progress from 1866 to 1869. 476 pages 8vo. Accompanied by Geological and Topographical Maps. (Dawson Bros., Montreal; B. Westermann & Co., N. York).—This volume contains a report of Sir Wm. E. Logan on a part of the Pictou coal-field, 50 pages; of E. Hartley on a part of the same coal-field, 52 pp.; of R. Bell, on the Manitoulin Islands, 9 pp.; of J. Richardson, on the South Shore below Quebec, 23 pp.; of H. G. Vennor, on Hastings Co., 28 pp.; of C. Robb, on a part of N. Brunswick, 27 pp.; of T. Sterry Hunt, on the Goderich Salt Region and Notes on Iron and Iron Ores, 94 pp.; of J. Richardson for 1869, 6 pp.; of R. Bell, on Lakes Superior and Nipigon, 52 pp.; of E. Hartley, on Pictou coals and Iron ores, and on Springhill Coal, 82 pp.; with an appendix containing a list of plants collected in the Manitoulin Islands, by Dr. John Bell. The excellent maps add much to the value of this interesting volume.

14. *North Carolina Tertiary.*—Mr. Conrad states in a recent letter to one of the editors, that the fossil horse of the marl near Greenville, N. C., mentioned in this Journal, last volume, on page 468, is, according to Dr. Leidy, the *E. complicatus*, a Miocene species that lived with the *E. fraternus.* The Mastodon from Raleigh (p. 469) is the *M. Americanus*, and was from Quaternary gravel overlying the Miocene marl.

15. *Volcano of Kilauea, Hawaian Islands.*—A recent letter from Rev. T. Coan states that the crater is at present in an unusually quiet state. Even the region of the great South lake, sometimes boiling with lavas over an area half a mile broad, is wholly inactive excepting the escape of vapors from fissures. At a depth of one hundred and fifty feet in some of these fissures a red heat may be seen, but no liquid rock.

VI. Miscellaneous Bibliography.

1. *Smithsonian Contributions to Knowledge.* Vol. xvii. 4to, pp. 590, with 14 plates.—This volume is devoted to an elaborate memoir entitled, "*System of Consanguinity and Affinity of the Human Family;* by Lewis H. Morgan."—This memoir was referred to a commission consisting of Prof. J. H. McIlvaine and Prof. William H. Green of Princeton, and after certain modifications suggested by them had been made, in the method of presenting the subject, it was submitted to a special committee of the American Oriental Society, consisting of Messrs. Hadley, Trumbull and Whitney, who, after a critical examination, reported that the memoir contained a series of highly interesting facts which they believed the students of philology and ethnology, though they might not accept all the conclusions of the author, would welcome as valuable contributions to science.

2. *Manual of Geometrical and Infinitesimal Analysis;* by Prof. B. Sestini. (Murphy & Co., Baltimore.)—In the brief space of 131 pages, the author gives a *manual* of the processes and results of Analytical Geometry and Calculus. While he does not claim to give a treatise, he briefly and lucidly develops all the important formulas of both branches of Analysis, especially the formulas reached in the study of Physical science.

A Dissertation on the Principles and Science of Geometry. By Lawrence S. Benson. New York: C. H. Phelps, publisher. 8vo.

Recherches sur la Polarization Rotatoire Magnétique des liquides, par M. le Professeur A. De La Rive. 8vo, pp. 46.

The Mineral and other Resources of the Argentine Republic. Published by special authority of the National Government, by Major J. Rickard, F.G.S. 1870. London: (Longmans & Co.)

Studien über das central Nerven-System der Wirbelthiere, by Dr. L. Stieder, of Dorpat.

Bulletin of the Museum of Comparative Zoology at Harvard College. Cambridge, Mass., vol. ii, No. 3. On the Mammals and Winter Birds of East Florida, with an examination of certain assumed specific characters in birds, and a sketch of the bird Faunæ of Eastern North America, by J. A. Allen. 450 pp. 8vo, with 5 plates.

American Journal of Microscopy, devoted to elucidation of scientific and popular Microscopy; E. M. Hale, M.D., Editor, Chicago. No. 1 of this monthly on Microscopy containing 32 pages, appeared in April last. It aims to distribute in a popular way interesting information on Microscopic objects throughout the country. Subscription price $2.00 per year, or 25 cents per number.

Introductory Text-book of Meteorology, by Alexander Buchan, M.A., F.R.S.E., Sec. of the Scottish Meteorolog. Soc. 218 pp. 12mo, with several maps. Edinburgh and London, (Wm. Blackwood & Sons). A good work.

APPENDIX.

Letter to the Editors from Dr. B. A. Gould, *Director of the Cordoba Observatory, dated Cordoba, April* 26, 1871.

When I wrote you, at the beginning of November, I felt small doubt that our Observatory would be in working order so far as mason work and carpentry were concerned, before the commencement of the New Year. The brickwork was completed at the close of November as I had anticipated; but even now as I write, the portion of the building which was first provided is not finished, although a very few days will enable me in all probability to begin the mounting of the instruments. So far as delays and interruptions of every sort are concerned, the enterprise has met with a very exceptional amount of obstacles, and only three days ago my instruments arrived from Germany after ten months of delay from war, ice, storms and quarantine.

The meridian circle and photometer are now securely housed, and, so far as I can yet judge, have suffered no essential injury. Our little library too has arrived, and I need not say with what earnestness we are looking forward to a sight of the catalogues and books of reference, now hidden within the iron-bound boxes. Should no unexpected obstacles arise, we shall be able to put up some bookcases, and unpack the boxes within the coming week.

It is now seven months since our astronomical party arrived in Cordoba, and during this long period we have been without instruments, and nearly destitute of books, notwithstanding the many precautions taken to avoid such a contingency. Fortunately I had brought with my personal effects the catalogues of Lacaille, Brisbane, Taylor and Ellery; and the catalogues published by the British Association were sent me from England. Thanks to these, I am indulging the hope that these seven months will not prove to have been spent in vain.

As intimated in my former letter, I resolved, as soon as the delays became manifest, to turn our attention to the formation of a Uranometry of the Southern sky:—in other words, to the preparation of a catalogue of all stars between the South Pole, and 10° of N. Declination, which are here visible to the naked eye, assigning to each star its estimated magnitude. This work has been now actively going on for six months, and with a degree of success which I had scarcely ventured to anticipate. The sky of Cordoba, although very far indeed from rejoicing in that eternal spring and unclouded blue which I had been led to expect, possesses when clear a wonderful transparency, and exhibits to the sharp eyes of my assistants an almost incredible number of faint stars, probably at least twice as many as can be seen in the most favorable nights at home. The lowest limit of visibility to the unaided eye, I have not yet undertaken to determine; but we see fully one-third of all the stars recorded by Lacaille as of the 7th magnitude, and we have a dozen or more of cases where Lalande has noted the star as 8th.

Our scale of magnitudes is based upon that of Argelander in his *Uranometria Nova*, and to secure as complete an accordance as possible our comparisons are made with stars observed by him within the zone comprised between 5° and 15° of N. Declination, since this zone has the same meridian altitude at Cordoba and at Bonn, and the light of the included stars is thus similarly affected by atmospheric absorption.

The establishment of standards of magnitude within this belt has been by no means the least laborious and troublesome portion of the undertaking; since no star is accepted as a standard to which the same magnitude has not been assigned by the independent estimates of four observers. The large number of stars within this type-belt, which could not be seen by Argelander in Bonn, affords an excellent measure of the transparency of the sky of Cordoba.

For constellations farther South the comparison is of course not so fair, on account of their superior altitude here, still you may form some idea of the work in hand when I tell you that in *Orion* we have twice the number of stars given by Argelander, and that in *Canis Major*, the whole of which is visible at Bonn, though to be sure its Southern boundary has only an altitude of a little more than $6\frac{1}{2}°$, we have 200 stars, while Argelander saw but 39.

A good deal more than half the work is now done; perhaps two-thirds of the hemisphere have been pretty well scrutinized, and the work of reducing the stars places to the mean equinox adopted is very well advanced. The total number of stars recorded thus far is about 4100, exclusive of those observed in the type-belt.

The delays of our instruments and of the Observatory building, though in themselves vexatious, have thus been compensated by the opportunity of preparing the Uranometry which ought to be essentially completed by the first of October, unless this should in its turn be too much delayed by the new work soon to be undertaken, in conformity with my original plan. An essential feature of my present scheme for the Uranometry consists in careful measurements of the magnitudes of stars above the 4th magnitude, and for these, of course, the greater part of a year must elapse after the photometer shall have been put in order by repairing the small damages which it has suffered on the voyage.

Our observations have greatly impressed me with the thoroughness and excellence with which Lacaille accomplished his work at the Cape of Good Hope with the poor means at his disposal nearly a century and a quarter ago. This devoted astronomer, having only a telescope half an inch in aperture and magnifying 8 times, observed, within a period of 11 months from the commencement of the series, something more than 100 zones, covering the region South of the Tropic of Capricorn. Like those of sundry other astronomers, most of his observations remained unreduced for the greater part of a century; but the catalogue computed from these observations at the expense of the British Association for the advancement of Science, and published by that body in 1847, contains the places of nearly 10,000 stars, which experience shows to have been determined with a degree of precision decidedly greater than he himself had supposed. And although his zones overlapped but little at their margins, so that only a small proportion of the sky was observed more than once, the scrutiny must have been extremely thorough for such stars as his little telescope would make manifest. The number of stars south of the Tropic, which we have detected, and which are not in his catalogue, is relatively quite insignificant, so that the task of identification has been by far less difficult than I was prepared to expect.

The recent publication, by Admiral Sands of the Washington Observatory, of Gilliss's Southern Catalogue of about 2000 stars affords a valuable supplement to Lacaille, since it gives observations of many stars for which there seemed reason to suspect errors in Lacaille's determination. And if, as recent letters from home give reason to hope, this is to be followed by Gilliss's splendid series of zone observations, comprising some 23,000 stars within 24° of the South Pole, observed in Chile twenty years ago, the Southern observer will receive a truly effective assistance in his labors. Indeed, after so long a period of apparent inaction, a new day seems dawning for stellar astronomy in the Southern Hemisphere. The careful and abundant observations of Maclear at the Cape of Good Hope, which have been accumulating for a quarter-century are now to be reduced and catalogued by his energetic successor Mr. Stone; and from the shores of Australia we are already receiving, thanks to the industry and ability of Mr. Ellery, an annual instalment of meridian observations, which may fairly challenge comparison with the most exact which are furnished by the first observatories of the Northern Hemisphere.

The difficult question of the Southern Constellations is of course now forcing itself in an especial manner upon my attention, in connection with the Uranometry. What constellations to retain, and what to disregard among the various suggestions of various astronomers, has been a less difficult question than the assignment of boundaries or the adoption of a definite and consistent notation from out the chaos which rules in sundry portions of the Southern sky. These matters, comparatively insignificant in many relations, acquire a supreme importance when questions of nomenclature become prominent, as in the work now in hand. Bayer, whose authority is accepted as law for the notation of Northern stars, named many of the Southern stars simply from descriptions given him by Southern navigators. Lacaille was either unaware of Bayer's notation or gave no heed to it, and later astronomers have increased rather than diminished the confusion. The difficulties were ably pointed out by the younger Herschel, but such few remedies as he suggested have tended rather to aggravate the evil, as for instance, in the case of *Argo Navis*, where the practical and effective suggestion, adopted by Baily, in the three catalogues of the British Association, of dividing this huge and unwieldy constellation into four smaller ones corresponding to the parts of the Ship, as indicated by Lacaille, is more than counterbalanced by the other recommendation, likewise adopted by Baily, that so far as the Greek alphabet is used, the original constellation be retained, while each of the four sub-constellations has its own special nomenclature in the two series of letters of the Latin alphabet. Nor are the three catalogues edited by Baily for the British Association altogether accordant as regards either the constellation-boundaries, or the notation of the stars, notwithstanding his efforts to furnish some relief for the existing confusion. The same Greek letter occurs twice in the same constellation in more than one instance in these catalogues, while other letters are entirely wanting.

Let me give you an illustration of the confusion encountered in a study of prominent Southern stars. Take the constellation *Telescopium*, one which has every reasonable claim to be accepted and retained. Here B is in fact η *Sagittarii*, γ, η, and o are in *Scorpius*, and σ is in *Corona Australis*. Or take *Piscis Austrinus* and follow the catalogues. Here Brisbane's ε is Baily's γ; Brisbane's η is Taylor's o and Baily's δ; Brisbane's γ is Baily's ε, while Taylor gives it no letter. Brisbane has two κs, one being Bayer's η, while Baily assigns no letter to the other; but Bayer's κ is γ *Gruis* of Lacaille (and Baily). Brisbane's ι is Baily's (and Bayer's) μ; of Brisbane's two δs one is Baily's τ, and the other has no letter in his catalogues; Brisbane's ν is Taylor's ω, while Baily gives no letter to it; Taylor's γ, ϕ and ψ have no letters given to them by either Brisbane or Baily. Indeed Baily puts ϕ in Aquarius.

Now the application of any general rule seems out of the question. For such stars as are visible in Central Europe, Bayer's notation should assuredly be retained, yet for many stars farther South, the star actually cannot be identified with certainty to which his letters were intended to apply. Where Bayer's notation fails, Lacaille's has the next claim; yet in many instances he has employed a letter already assigned by Bayer in a more Northern portion of the same constellation. Not unfrequently too Baily has attempted to improve upon both Bayer and Lacaille, and not with the best success; yet inasmuch as every existing Southern Observatory, so far as I am aware, has been organized by some astronomer whose native tongue was English, and who has therefore depended to a greater or less extent upon the three catalogues of the British Association, this "improved" notation, like the "improved" notation of Bessel's star-constants, a, b, c, d, has found a wide adoption.

Add to this that, so far as I am aware, no attempt has been made to give precise boundaries to the several constellations, and you will see that the task of arrangement is no slight matter, when every visible star is to be assigned to some definite constellation. This implies the establishment of boundaries,

and one needs but to glance at any celestial globe or atlas to convince himself that this is a process more easily spoken of than accomplished. If performed in a manner acceptable to astronomers it will find prompt adoption, and evoke order from confusion; if, however, it should fail of approval, it will but add one more chaotic influence. Any attempt at such a revision and establishment of boundaries should be restricted by certain fixed regulations, prescribed in advance, and not to be transgressed upon any pretext; if such can be judiciously laid down, and yet found upon trial not to be incompatible with an arrangement of boundaries easy of recognition and of description, I see no reason to doubt their glad reception by astronomers, as a simple means for substituting for the existing confusion a well ordered and unmistakeable system.

Notwithstanding some misgivings, I am at present occupied in the attempt to arrange the Southern constellations in such a way that the changes may be regarded by astronomers as only for the better.

During the last week we have unpacked the equatorial, and have mounted its bed-plate upon a pier of white marble, from the Sierra four leagues away. The instruments appear to have arrived in perfect condition, and as soon as the dome is made rain-tight, and the interior of the building plastered, I shall proceed to the mounting of the telescope, for which all needful preparations are already made. That the shutters should be rain-tight, is a much more essential condition than I had been led to suppose, for the summer rains here are sudden and vehement. The theory of an eternal summer is thoroughly disposed of; for during the last three months we have not had a dozen perfectly clear nights, the sky being overclouded with almost perpetual nimbus, although very little rain has fallen This, I am informed, is the ordinary character of the weather during a considerable part of March and April, the autumn being ushered by a long cloudy season. I wrote you before that I had known no rain here without abundant thunder and lightning. During this long cloudy season a light misty rain has several times occurred without electrical manifestations, although as regards regular showers or copious rains, I have seen no reason to change my earlier impression. The rainless season is now said to be close at hand. It will assuredly find with us a cordial welcome.

It is to be expected that in the course of our work we may encounter a number of variable stars sufficient to make the number in the Southern Hemisphere approximately equal to that of those already known north of the Equator. As yet however we have not followed through any very decided changes, although there is a considerable number of stars whose magnitudes, as observed by us, differ widely from those recorded by other astronomers, and which also appear to have varied during the period of our observation.

The star η *Argus*, has naturally attracted a good deal of my attention. It is at present not far from the $6\frac{1}{2}$ magnitude and recognizable with great difficulty by the naked eye. In the field of my small Tolles telescope of 5 in. aperture, and 35 in. focal length, it is a conspicuous object, and prominent by its ruddy color among the cluster of which it forms a part, against the bright nebula as a background. With this telescope, the same one which I employed for observing the total eclipse of 1860, I have been examining the whole group; and have found to my astonishment that it exhibits with distinctness a considerable number of stars, which are recorded in Sir J. Herschel's catalogue of this cluster, as being of the 14th magnitude.—(*To be continued.*)

Party of Geological Exploration under Prof. O. C. MARSH.—Prof. Marsh, with a party of twelve, is about leaving for the Rocky Mountain region and the Pacific coast, to continue his investigations with reference to the Cretaceous and Tertiary vertebrates of the region. He will be absent about six months.